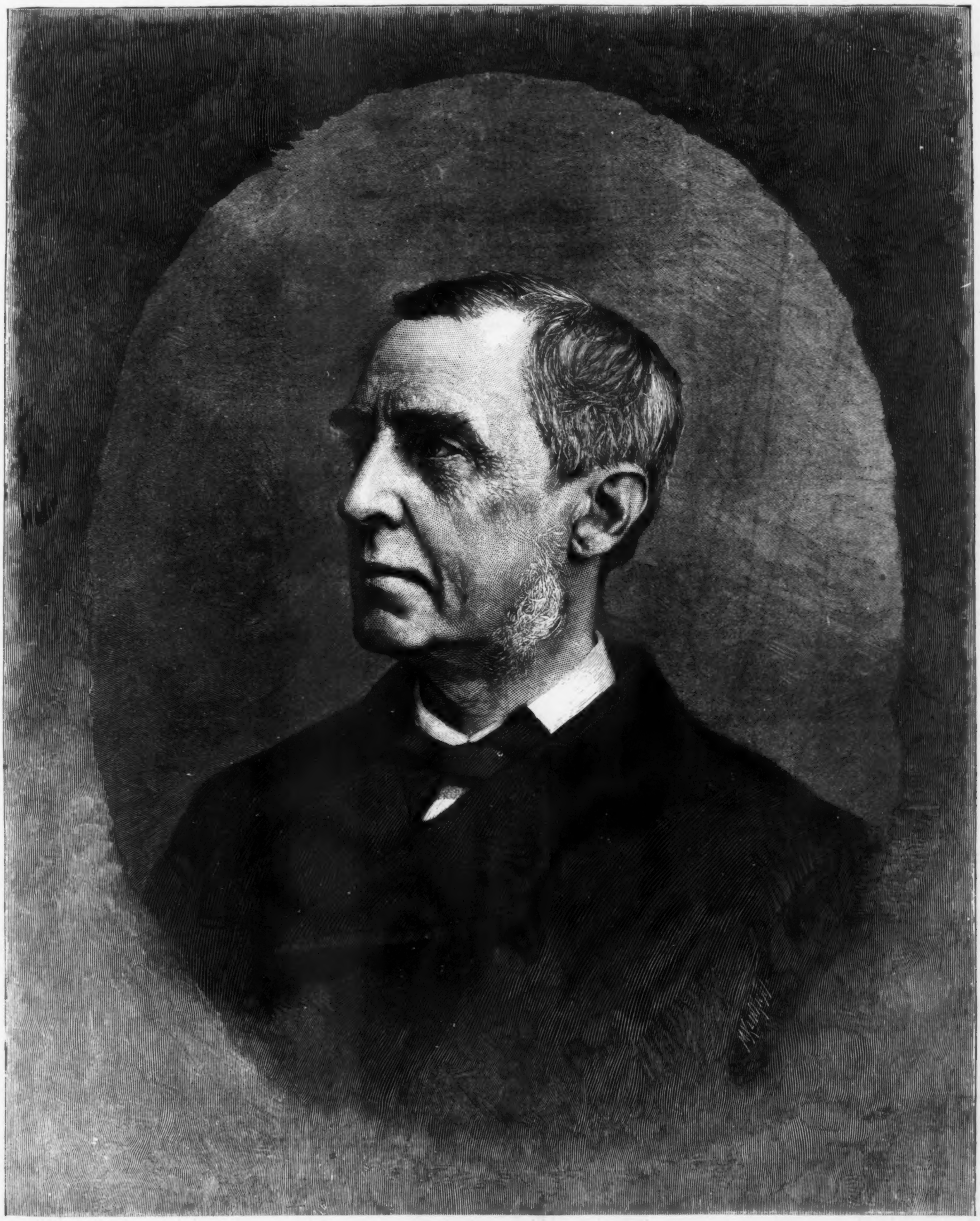
SCIENTIFIC AMERICAN SUPPLEMENT. No 987

Scientific American Supplement, Vol. XXXVIII. No. 987.
Scientific American, established 1845.

NEW YORK, DECEMBER 1, 1894.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.



JAMES ANTHONY FROUDE.—From the Illustrated London News.

[From the Illustrated London News.]

THE LATE MR. J. A. FROUDE.

The death of James Anthony Froude recalls some of the most stirring and exciting scenes in the literary life of the Victorian era. Mr. Froude had been a combatant in at least three great struggles; he was a figure in the Tractarian movement; he was the very center of the struggle which gathered around the figure of Henry VIII.; and finally, scarcely any book has evoked more criticism than his "Life of Thomas Carlyle." Under these circumstances it is difficult to say whether Mr. Froude will live more as an historian than as a biographer. His historical work has a value which it shares to some extent with Macaulay's. He has obtained a reputation for inaccuracy—the very opposite quality to that which, as a rule, goes to make an historian. Freeman and Stubbs, Lingard and Hallam, whatever their defects, are rarely caught napping, but they are not stylists, and Mr. Froude is before all things a stylist. No one who has read those twelve volumes of his history but has felt carried along, step by step, through all the entrancing chapters. We may have felt certain that Mr. Froude's special plea on behalf of Henry VIII. was false and unsound, and that his detraction of Elizabeth was nearly equally baseless; but we can never forget the grim picturesqeness of his account of Queen Mary's execution and of the Pilgrimage of Grace. Mr. Froude, by these vivid word pictures, has stamped himself upon the literature of the era. A historian like Lingard lives only as a tradition, or lives only as the historian of a church. Mr. Froude, infinitely more intolerant and certainly more inaccurate, will live because he was a great master of literary English. Just take one passage as an example, and it is one out of of hundreds we might quote, to show a certain striking method which characterized his work. He is dealing with the rise of Protestantism and the execution of More and Fisher:

"While we exult in that chivalry with which the Smithfield martyrs bought England's freedom with their blood, so we will not refuse our admiration to those other gallant men whose high forms, in the sunset of the old faith, stand transfigured on the horizon tinged with the light of its dying glory."

Mr. Froude's standpoint is, of course, the standpoint of Carlyle, and it is interesting to remember that of all the band of brilliant men who surrounded the Chelsea prophet Mr. Ruskin alone survives to-day. That standpoint was summarized in Lord Tennyson's well known lines:

> O God, for a man with heart, head, hand,
> Like some of the simple great ones gone
> For ever and ever by!
> One still strong man in a blatant land,
> Whatever they call him, what care I?
> Aristocrat, democrat, autocrat—one
> Who can rule and dare not lie.

Looking around for a strong man, Henry VIII. naturally occurred to Mr. Froude, and hence his great work, the joy of writing which was doubtless intensified by the manifold opportunities of attack upon ecclesiasticism, from which Mr. Froude was suffering so severe a reaction.

But Mr. Froude is not alone the historian of Henry VIII., of Edward VI. and of Elizabeth; he has given the world many interesting biographical works. Most striking, perhaps, of all his literary efforts are his "Short Studies," in which the Essay on Job is perhaps the most brilliant. Then we have the "Life of Carlyle"—the discussion of which is within the memory of every one; the "Life of Bunyan," the "Life of Cæsar," the "Life of Lord Beaconsfield," and the "Life of Erasmus"—published some few days before his death—all books which have an individuality of their own, even though they show with sufficient emphasis certain defects of the writer. It is of less importance in criticising Mr. Froude's literary career to name his books of travel, his "Oceana" and "England in the West Indies;" and it is still less important to name his works of fiction, of which several were published at the beginning of his career, and "The Two Chiefs of Dunboy" within the last few years.

Mr. Froude was born in the year 1818, at Dartington, Devon, and was the son of the Ven. R. H. Froude, Archdeacon of Totnes. He was one of three gifted brothers, another being William Froude, the mathematician and engineer; and the third Richard Hurrell Froude, a leader of the Tractarian movement, whose "Literary Remains" were published after his death by Keble and Newman. Mr. Froude was educated at Westminster School and at Oriel College, Oxford; he wrote two novels in 1847, "The Spirit's Trials" and the "Lieutenant's Daughter," and published his "Nemesis of Faith" in 1848. Between the years 1856 and 1869 he published his "History of England;" his after career has no more noteworthy events than his travels, his commission to South Africa, his "Life of Carlyle," and his succession to Mr. E. A. Freeman as Regius Professor of History at Oxford. He married a sister of the late Mrs. Charles Kingsley.

MEETING OF THE NATIONAL ACADEMY OF SCIENCES AT NEW HAVEN.*

The meeting of the National Academy of Sciences at New Haven recently was in every sense a successful one, the attendance being unusually large for an autumn meeting, and the papers being in number and quality quite on a par with those of the Washington meetings. The scientific air which surrounds the great university of Yale was in every way congenial, the Elm City being termed by some the scientific center of gravity of the country, lying as it does nearly midway between the exceedingly strong centers of Washington and Boston. Curiously enough, New York City was not represented at all, no one of the academicians there located having come to meet and greet his fellow members.

The hall of meeting, the fine lecture room of the Sheffield Scientific School, was in almost every respect perfect, presenting the sole inconvenience, common to such amphitheaters, of an awkward half-step between the levels of the ranges of seats. It is indeed a fine hall in a notable group of buildings, the older ones of which have the merit of antiquity, while the newer ones depart from that utilitarian look which distinguishes the physical laboratories in and about Boston.

On Tuesday morning, the members of the academy came together, and a distinguished company it was. The dignified Dr. B. A. Gould, Boston's own great astronomer, and his less portly and more active companion and pupil, Dr. S. C. Chandler, who is day by day emulating the example of his teacher and surprising astronomers by the quantity and quality of his investigations, met in friendly converse with Prof. Asaph Hall, of Washington, and the New Haven astronomers, Prof. Newton, still active in the good work, and Dr. Elkin, with a career just begun—and well begun, it should be added. Physicists there were in number, Prof. Michelson, who carries wave lengths of light in his vest pocket; Prof. Hastings, under whose care the organization of Yale's great physical laboratory has been effected; and Prof. W. A. Rogers, formerly of Harvard, but now in charge of a special department at Colby University. The geologists were headed by the venerable Prof James Hall, State geologist of New York, to whom more than to any other one man the geology of this country is indebted. It was he who, finding the open pages of the geological story spread in the upturned strata clear across his State, judged at the outset of the importance of beginning well, and laid the foundations of so judicious a system that his work is already almost classic. His appearance among the younger workers of to-day is hailed with enthusiasm, and applause greets his authoritative utterances. Speaking of him, his fellow investigator, Prof. O. C. Marsh, the president of the academy, himself an authority in these matters, publicly paid tribute to him. "The Nestor of American Paleontology, who, after half a century of work, comes before us with unabated freshness and energy."

Other departments of science were by no means unrepresented; chemistry was upheld by Dr. Walcott Gibbs; mathematics by the other Dr. Gibbs, who summed up his paper with conclusions with reference to "flux in n dimensions of space," and by Prof. G. W. Hill, who really gives interest to no problem less intricate than the moon's mean motion; natural history boasted of visitors from Boston and the splendid home talent of Prof. Verrill; while education felt itself proud to have present, as representatives, the heads of three of our most prominent New England institutions of the highest order. Later in the sessions there came other talent, Prof. Clarence King, the director of one of our great governmental surveys, Prof. Lewis Boss, who has made the Dudley Observatory at Albany so sturdy a support of American astronomy of precision, and Prof. S. P. Langley, who, with the cares of the Smithsonian Institution upon his shoulders, to say nothing of the problems of aero-navigation, has still the time and the energy to extend into the unknown his remarkable investigations into the character of the invisible part of the solar spectrum. To be in such a company, the flower of America's scientific men, is of itself a liberal education, while to mingle with the great men in a social way, in the less guarded moments, so to speak, in the cozy halls of the clubs, whose doors were thrown wide open to welcome the visitors, or at the reception of the president of Yale College, is at every moment replete with interest and entertainment.

Several of the papers presented were of a geological turn, New Haven, under the tutorship of Prof. Marsh, having developed many active and energetic young students of the earth's past history. Of these, the most interesting was the topic presented by Prof. C. E. Beecher, a report of progress in the investigation of the brachiopods. These strange bivalves, by far the most numerous of the molluscan forms, wide in distribution both geographically and geologically, remain to us to-day in but a few living species, and of these it has been possible to study but an exceedingly small number. But the fossil forms, preserved to us in imperishable shape, may be followed throughout their development in very many of their species. This record of the development of life is open to the geologist and presents an interesting chapter in the great volume of the world's history before the advent of man. Another of New Haven's geologists, Prof. Williams, pointed out in unmistakable argument that, among fossils as with men, there are some unruly specimens which are out of place, some lingering species which, like the last rose of summer, had lived on after their companions and fellows had passed away. Geologists will receive Prof. Williams' facts with the greatest of interest, for the philosophical presentation of them and the manner in which he guarded against possible error in the relations of the fossils to the strata in which they were found seem to establish his deductions without possible discussion.

The paper which has perhaps the widest scientific interest among those presented at New Haven was that of Dr. S. C Chandler on the motion of the pole. This is a familiar subject both to the Academy and to the readers of the Commonwealth, who have watched with interest the gradual unfolding of Dr. Chandler's solution of the problem. The matter has attracted the attention not only of astronomers and physicists, who are directly interested, but also of meteorologists, geologists and many other ologists, all of whom hope to find in this new motion and the forces which cause it or result from it some explanation of puzzling discordances within their own special fields of research. It is unnecessary here to dwell longer on the investigation, for it is worthy a fuller statement at some future time; but the succession of remarkable discoveries has been most astonishing to those who are familiar with the progress of the work. Dr. Chandler has made at no time any statement which it has been necessary to retract, although, as might be expected, a refinement of the motions has resulted from the application of more extended series of observations. His larger motion has been refined to a value less than half a day at variance with his earliest value, while his second motion becomes refined to an ellipse instead of the circle which at first it seemed to be. The resultant of these motions conforms to the actual observations through crucial points, so that in all America there is not an astronomer of standing who does not concede to Dr. Chandler the successful solution of a problem whose coarsest elements are the most refined measures of the modern astronomer.

It is true that abroad his conclusions have met with some opposition, on the general ground that he is dealing with quantities too small to measure, and some of these opinions have been sedulously circulated in this country with a view to belittling Dr. Chandler's authority as an astronomer; but it is simply necessary to state that such opinions have in them no knowledge of his latest developments, for such information at its best travels but slowly, and that the position of these men is but a repetition of that of our own astronomers a while ago, who, through a better understanding of the fundamental nature of Dr. Chandler's researches, have been forced to acknowledge the correctness of his conclusion and the absolute truth of his laws. His investigation of this subject is perhaps the largest and most important research ever undertaken by any one unconnected with some institution, and the presentation of his results at the National Academy is always a matter of the greatest interest.

Not only were there scientific communications in order at the meeting of the Academy, but business of importance was under consideration. The item of the greatest interest to the outside world was the direct exercise of one of the functions of the Academy in its capacity as the scientific aid and adviser of the government. Strange as it may appear, the community which has come to utilize so enormously the different forms of electrical force has had up to this time no legal units for these forces. There have been, it is true, scientific names—the ohm, volt, ampere, etc.—but these names have had no standing in law. The consumer has had no possible course save the acceptance of what has been furnished to him, and has had no legal redress should he deem the product inferior in quality or short in quantity. The best means out of the difficulty was a prominent subject for discussion at the Electrical Convention in Chicago last year, where, however, the influence of the great producers militated against a strictly scientific report. This report has been communicated to the different governments, and some of them have passed laws legalizing certain of the units. In this country the matter was brought to the attention of Congress, and all eight of the units named by the convention have been legalized; the determination of them, however, having been referred to the National Academy, whose selection and definition of the units will be the legal standard. A most important duty, therefore, has fallen upon the Academy, and one to which it will immediately give its most expert consideration through a committee shortly to be named.

This instance is the second one only in the history of the Academy when its opinion has been directly sought for by act of Congress, the previous occasion having been the suggestion of a solution of the Geological Survey tangle of some years ago, the result of which was the organization of the present survey. It is true, however, that the opinion of the Academy is frequently sought, several times each year, by the different departments of the government.

The establishment of the electrical units is also the first instance in which our government has sought to legalize any units whatever of measurement.

John Ritchie, Jr.

* From the Boston Commonwealth.

[From the Nineteenth Century.]

THE PEOPLE'S KITCHEN IN VIENNA.

By Edith Sellers.

Some twenty-five years ago there was great distress in Vienna. The people were heavily taxed and had little wherewith to pay their taxes, for work was scarce and wages were low, while the cost of living was extremely high. In tenements and rooms of the poorer kind in the city there are no conveniences for cooking; the working classes are, therefore, obliged to live on wurst and such unwholesome things, or to go to restaurants for their dinners. In those days, however, a dinner in a fourth rate restaurant cost seven pence at least, a big sum for a man to pay who was earning perhaps eight shillings a week and had a wife and children to support. The majority of laborers, even when in constant employment, could not afford to dine every day, and as for casual workers, it was only on high holidays that they had a regular meal. The great mass of the wage-earning population, in fact, was miserably underfed, to the detriment of the whole community.

Dr. Josef Kuhn, a practical philanthropist who had made an exhaustive study of the subject, was convinced that this state of things was the result, not so much of the poverty of the workers, great as it undoubtedly was, as of the rapacity of those upon whom they were dependent for their food. The dinners for which they paid sevenpence did not cost threepence; thus the restaurant keepers were levying a toll of more than 100 per cent. on every meal they sold to the neediest class of their customers. Food, good in quality and sufficient in quantity, might, the doctor maintained, be brought within the reach of all wage earners, if those who supplied it, instead of being extortionate traders, were men prepared to give full value for the money they received. He therefore proposed that, in the poverty stricken quarters of the city, there should be opened, under public management, restaurants in which food should be sold at the lowest possible price compatible with their being self-supporting. According to his plan, the money necessary for the initial expenses in connection with these establishments was to be raised by public subscriptions, no profits were to be made, and the cost of management was to be minimized by honorary officials being employed. In other respects the undertaking was to be conducted on strict business principles, all who frequented the restaurants paying for what they received exactly what it cost. Dr. Kuhn's scheme was greeted by the Viennese with great sympathy. It was, however, unanimously condemned as impracticable. No one would believe that a restaurant could be managed by amateurs, and the idea of an institution organized on the lines suggested being self-supporting was held to be absurd. The doctor soon discovered that if the work on which he had set his heart was to be done, it must be by the individual efforts of himself and his friends; no collective action on the part of the city was to be counted upon.

For two years he devoted himself to studying the working of restaurants and perfecting the details of his scheme. Then, in 1872, in conjunction with four

other gentlemen, he organized the People's Kitchen Association. The very raison d'etre of this association was, and is, to provide the working classes of Vienna with nutritive, palatable food at prices within their means. It began its operations on a somewhat humble scale. Each of its members subscribed five hundred florins, and with this money a restaurant was started in the Hechtengasse. At first the restaurant was open only from half past eleven o'clock until two, during which time dinners were served at a charge of fifteen kreuzers (threepence) or eight kreuzers each. For fifteen kreuzers, a slice of beef or mutton weighing eight dekagrammes and forty centiliters of vegetables were supplied; for eight kreuzers, four dekagrammes of beef or mutton and twenty-five centiliters of vegetables. The Hechtengasse is in the center of a densely populated district in which are several large factories; the new restaurant was well placed, therefore, for securing customers. The fame of its threepenny dinners soon spread through the neighborhood, and before many weeks had passed it was thronged from the moment the doors were opened. Soup at three kreuzers the plate was then added to the menu; vegetables, too, at four kreuzers for fifty centiliters, and puddings, omelets, macaroni, cheese, etc., at eight kreuzers the portion. Low as were the prices charged, the restaurant was almost from the first self-supporting. It thus afforded a startling proof of the extent to which the poor had previously been exploited by those of whom they had bought their food.

When once the success of the first venture was assured, strong pressure was brought to bear on Dr. Kuhn to induce him to open a people's kitchen, as he called his restaurant, in every district in Vienna. This, however, he refused to do. Much of the organization of his undertaking was still in the tentative stage; he was afraid, therefore, lest any sudden extension of its work should throw the whole concern into confusion. All that he could promise was, that the association, of which he was the president, would open two more restaurants as soon as the necessary arrangements could be made. At the same time he proposed that other kitchen associations should be formed, and that these, although perfectly independent, should act in friendly co-operation with the one he had founded. The Princess Hohenlohe-Schillingsfurst was the first to act on this suggestion. She organized an association which opened a kitchen in the Leopoldstadt district. In 1874 the Princess Liechtenstein helped to start one at Meidling. In the course of the following two years three more independent associations were formed, each of which has now a kitchen of its own. A particular interest is attached to one of them, owing to the fact that it is organized for Jews. In the kitchen it has opened the food is dressed according to their peculiar ordinances, and special preparations are made for the Jewish festivals. Meanwhile, the First Association, as that organized by Dr. Kuhn is now called, was hard at work. In December, 1873, it opened a kitchen at Neubau, and two months later, one in Mariahilf. In 1875 it began to supply not only dinners, but breakfasts and suppers in its restaurants, and it further extended its operations by providing special meals for poor children. Since then it has established five more kitchens, all in populous districts. Thus there are at the present time in Vienna thirteen people's kitchens, eight under the direction of the First Association and five belonging to the allied associations. They are all founded on the same principle, all worked on the same lines, and are all self-supporting. Their operations are now conducted on quite a colossal scale. Their supplies are bought by the thousand tons, their soup is made by the thousand gallons, and sometimes as many as 2,400 persons a day dine in one kitchen.

Practical common sense is the chief characteristic of the organization of these people's kitchens. The system adopted by the First Association has served as a model for others. This association is open to all who choose to join it. On the 1st of January, 1892, it had on its roll 398 members, viz., 245 honorary members and 153 ordinary members. Honorary members are persons who have rendered some special service to the association, or who have made it a donation of 500 florins, or who subscribe annually ten florins. Ordinary members are those who subscribe annually at least one florin, or who have held some honorary office in a kitchen for six months or longer. The management of the affairs of the association is vested in an executive committee, which is chosen at a general meeting of the members. This committee holds office for three years, one-third of its members retiring every year. It consists of a president, two vice-presidents, a treasurer, an auditor, two secretaries, two professional advisers (an architect and a doctor), the local directors, the lady superintendents, and the assistant superintendents of the eight kitchens belonging to the association. These are all honorary officials, but attached to the committee are three—a general secretary, a bookkeeper and a kitchen inspector—who are paid. The members of the executive occupy the position of the directors of a public company, and are responsible for the entire working of the kitchens. They seek out cheap provision markets, make contracts for supplies, fix the weight and price of the food portions sold, engage the matrons and cashiers, and decide where and when new kitchens shall be opened. They also verify accounts, regulate expenditure and have full control of the finances of the association. They must, however, submit their books and balance sheet to the scrutiny of a special revision committee appointed by the members of the association. The executive meets once a month, and delegates its authority in the intervals between its sittings to its president.

Ever since the first association was formed Dr. Kuhn has been its president—a president, too, who devotes himself heart and soul to promoting its interests. He visits the kitchens constantly, tests the food, sees that the officials do their work, and that everything is going smoothly. He is always on the alert to secure for his customers good value for their money—to gratify, too, their tastes and their wishes. He invites them to make suggestions for the improvement of the kitchens, and listens to all criticisms with a patience that knows neither bound nor limit. His chief coadjutors are the lady superintendents, most important officials. Each kitchen has its own lady superintendent. She is responsible to the executive, practically, for the whole management of her kitchen; for, although the matron is responsible for the food supply, the cooking and the domestic arrangements of the establishment, she is responsible for the matron. She checks the matron's books and watches over the general expenditure, for all the money spent passes through her hands. She takes charge of what is received for the tickets sold, and certifies that it corresponds in amount to the value of the food served. In consultation with the matron, she issues orders for provisions and decides on the menu for the day. She is, in fact, in the position of the mistress of a large establishment, and the matron is as her housekeeper. She has certain social duties, too, to perform. She must organize a local committee of ladies who will undertake to interest themselves in the work of the association, and be present in turn in the kitchen while dinners are being served. She herself, or one of her two assistants, must be there every day at least from eleven until two. Thus the office of a lady superintendent is no sinecure; upon her fitness for her work, in fact, depends in a great measure the success or failure of the kitchen.

There is no more interesting place in all Vienna than a people's kitchen. The most important is the one in the Hechtengasse, only a few hundred yards away from the house in which the first association began its work, twenty-two years ago. It is held in a fine, handsome building, which was erected in commemoration of the fortieth anniversary of the Emperor's accession, the money for it being raised by the late Princess Auersperg. The kitchen itself consists of two very large, lofty rooms, one on the right of the hall, the other on the left. In each of them are a number of long tables covered with American cloth, and having benches on either side. The room to the right is the principal dining hall. The upper part of the one to the left is cut off from the rest by a counter, beyond which the public are not allowed to pass. Here is the huge fireplace at which the food is cooked and kept hot until the time comes for serving it. A marked feature of the kitchen is its scrupulous cleanliness. Although many hundred persons pass through it every day, the air is always fresh and pure; and there is never a sign of dust or untidiness. The white china plates and dishes are spotless; the knives and forks are brightly polished; while as for the glasses, they literally sparkle.

Attached to the kitchen are fourteen paid servants—a matron, two assistant matrons, a cook, an assistant cook, two kitchenmaids, two scullerymaids, a washer-up, a general helper, two men waiters, and a cashier. They are all hard at work by half past five in the morning, for by six o'clock they must have breakfast ready for the men who call on their way to the factories. Breakfast is a very simple meal, soup, tea, and bread being the only things provided. A portion of soup, or of tea, costs three kreuzers; a white roll, two kreuzers; and a slice of brown bread, one. For eight kreuzers, therefore, a good breakfast can be had; and, as most of the workmen are content with soup and brown bread, they pay only four kreuzers (four-fifths of a penny) for their meal. After eight o'clock no breakfasts are served, for then preparations for dinner begin. The cook and her assistants since six o'clock have been chopping and paring, and stewing and boiling; for a meal for two thousand persons or more is not to be prepared in a hurry. When the cooking is done, the dividing out begins. This is the work of the matron, and most tiresome work it is; for, as the association makes it a point of honor that every portion shall be exactly equal in size and quality, each one of them has to be weighed.

The first guests to arrive are always the school children; for, as they are received on special terms, and have a menu of their own, they are admitted only from eleven until a quarter to twelve. They come trooping in with their tickets in their hands in the most orderly fashion. Some are thinly clad, poor little things, who look as if their lines were cast in very poverty-stricken places; while others are evidently the children of well to do artisans and small shopkeepers. But differences of rank are as nothing in a people's kitchen; all there are on terms of equality, for brass tickets tell no tales Those the charitable give to teachers for the children of the poor are just as bright as those wealthier parents buy for their own sons and daughters. The little ones themselves do not know who pays for their dinners. Thus in Vienna a solution has already been found for the problem which is so sorely perplexing our school boards. During the winter months some thousands of children often dine in the kitchens. They are given every day a large white roll and a plate of pea soup, milk pudding, cabbage, or sauerkraut. The portions are as large as an ordinary child can eat, and the charge for a dinner is five kreuzers. No sooner are the children gone than the general public begin to arrive; and from twelve o'clock until nearly two the kitchen in crowded.

The menu for the day is written on a huge slate which hangs near the door. That menu is a curiosity; it is never twice the same in one week, and the variety of dishes it includes, in the course of the year, is simply marvelous, considering the prices charged for the dinners. The list the lady superintendent and the matron have to choose from, when deciding what shall be given on any special day, comprises fifteen kinds of soups, eighteen vegetables, meat of one sort or another dressed in twenty-one different fashions, twenty-nine sweets, six salads, to say nothing of such trifles as entrees. The following may be taken as fair samples of the dinners the First Association provides for its customers:

	Kreuzers.
Groat soup	3
Peas	4
Beef with peas	8 or 15
Venison with macaroni	8 or 15
Raisin pudding	8 or 15

	Kreuzers.
Clear soup	3
Spinach	4
Beef with spinach	8 or 15
Pork cutlets with potato salad	8 or 15
Fruit pudding	8 or 15

Each dish is perfect in its way, carefully prepared and delicately seasoned. All the ingredients are of the best quality, and they are cooked by highly trained professionals, who rank, in point of skill, with those employed in the clubs epicures frequent. And these are the dinners of the poor, nota bene, of the class which in England must content themselves with bread, cheese and perhaps a rasher of bacon. As everything is sold a la carte, no one need spend more than he chooses on his meal. The average cost of a dinner is eighteen kreuzers, though the prices range from twenty-five kreuzers to six. It is an almost unheard of thing for the persons who dine in the kitchen to have a slice of the joint as well as a portion of the other savory dish; a very large percentage of them, indeed, have only fifty centiliters of vegetables and twenty dekagrammes of bread. For this somewhat meager meal they pay six kreuzers.

Customers, unless they go provided with tickets, must buy them at the door, where the cashier sits, for no money is taken in the kitchen. Their first business is, of course, to examine the menu and make up their minds what they will have for their dinners. They then take up their places in the long row of persons trying to reach the two lady visitors, who stand near the counter where the dishes are served. One lady examines the tickets, while the other hands the portions of food which correspond to them in value. A servant who is near gives a white roll or a slice of brown bread to each guest as he passes; and a second provides him with a knife, fork, and spoon. He must then find for himself a seat, a difficult matter sometimes; and, if he wishes for water (nothing else is allowed to be drunk) he must fetch it from the tap.

It is a somewhat motley company, it must be confessed, that meets together day by day in that Hechtengasse Kitchen. All sorts and conditions in truth are there: students whose science is deeper than their purses; ex-criminals with tickets given them at the prison door perhaps; and gentlemen who have backed the wrong horses. Of women, of course, there is never a lack: actresses whose beauty is faded, unsuccessful artists, and the widows of professional men. People who have wasted thousands in their day sit side by side with those whose lives have been one fierce, hopeless struggle to make both ends meet. It is the common rendezvous, in fact, of failures of every sort and kind. Still these are only the exotics, as were; the great mass of those who frequent the kitchen belong to the wage-earning classes, and are hard-working men and women. Carpenters, masons, postmen, seamstresses, flower sellers, shop girls, all dine together; and scattered among them are shoeblacks, crossing sweepers, and even beggars. The beggars, however, who go must, for the time at least, cast aside their role; for nothing that smacks of alms, whether the giving or receiving, is tolerated. The kitchen itself is not a charity, it must be remembered, but a business concern—a fact its managers are always careful to impress on their guests. Every dinner is paid for, and whether by him who eats it or by some one else, it is no affair of theirs. Thus those who go there are subject to no humiliation; no call is made on them for gratitude or thanks; they are there on precisely the same terms as in any other restaurant. The treatment they receive in the kitchen differs only from what they receive elsewhere in its greater courtesy; instead of rough attendants to wait on them, they have ladies. It is the special duty of the honorary officials to see that no guest is neglected. During dinner, the lady superintendent, Madam Fischer-Ullrich, the local director, and a lady visitor, go from table to table soothing the impatient with tactful words, lavishing kindly attentions on all comers, and removing every cause of friction. The good tempered courtesy, which is so marked a characteristic of the Hechtengasse Kitchen, is undoubtedly due in a great measure to the personal influence of Madam Fischer-Ullrich and her assistants, to their ceaseless efforts in promoting the general comfort. A rough word is rarely heard in the kitchen, and, what is always a good sign, the most comfortable seats are yielded to the old and feeble without a murmur. Two detectives are present during the dinner hour in case disorder should arise; but it is a most unusual thing for recourse to be had to their services. At two o'clock the kitchen is closed, but it is opened again for supper from six until nine. Then tea, soup, ham, cold beef, salad, hot vegetables, and the remains of the dinner rechauffe are served. The average cost of a supper is ten kreuzers.

In the course of the day more than twenty thousand persons on the average are now provided with food in the people's kitchens. And these are far from forming the whole clientele of the associations. In Vienna as elsewhere there are people who cannot afford even a five-kreuzer dinner. There are others who are too feeble to go to a restaurant; others, again, who object to eating in public. Special arrangements are made for the benefit of such as these. At certain hours in the day, the kitchens are open for the sale of food to those who wish to take it away with them. People who have invalids in their houses can procure for them in this way suitable nutriment at a small cost. And women with large families may fetch a quart of soup, a milk pudding, or whatever else they can afford, and, safe from curious glances, divide it among their children by their own fireside. The First Association also undertakes to distribute food, in almost any quantities, wherever it may be required. At the request of the burgomaster, it will organize at a few hours' notice special dinners for the unemployed. In this way it renders good service to the authorities in seasons of unusual distress. The cost of these meals is defrayed either by the municipality or by public subscription.

The remarkably low price at which food is sold in the people's kitchens must be ascribed, in some measure, to the gigantic scale on which the undertaking is conducted. The associations require such vast quantities of provisions that they are able to open out new markets for themselves, in places where the supply is great and the demand is small. Vegetables and dairy produce, for instance, are transported by the wagon load from remote country districts, where they are bought at considerably under wholesale market prices. As every housewife knows, too, the cost of preparing food varies, within certain limits, in inverse ratio with the quantity prepared. Whatever may be the cost of one gallon of soup, two gallons of the same quality can be made for much less than twice the sum; while a hundred gallons, if made together, do not cost so much as fifty made separately. In the Hechtengasse Kitchen, soup is prepared by the 6,710 liters at a time, and all other provisions on the same scale. The skill with which the kitchens are organized and managed by their honor-

ary officials is also a very important factor in determining the price at which the food is supplied. The working expenses are kept down by the practice of the most rigid economy in every department. The matrons are all highly trained housekeepers who are accustomed to dealing with large stores of provisions, and who know to a nicety the materials required for every dish. It is their duty to see that no waste occurs. A considerable saving is effected, too, by employing only thoroughly good cooks of wide experience. The result of this rule is that there are no mistakes in seasoning; no food has to be thrown away as uneatable; but every dish prepared is of the best quality.

A special interest is attached to the economic arrangements of the people's kitchens, owing to the financial condition of all the associations being so extremely satisfactory. So far as the food supply is concerned, the kitchens are entirely self-supporting. The number of kreuzers paid for a breakfast, dinner, or supper represents the full cost of these meals—the bare cost of course, without any addition for profits, expenses of management, or interest on capital. All that the executive committees require is that the receipts of the kitchens, taken collectively, shall balance the expenditure, and leave a trifle in hand against an evil day. If it is found there is a surplus of funds, some of the portions of food are increased in size; if, on the contrary, there is a deficit, they are made somewhat smaller. During the year 1891, the first association cleared its expenses, and was left with a balance in its favor of 4,108 florins. It is, therefore, entirely independent of outside pecuniary aid and it will ultimately return to the community, in one form or another, whatever money it receives. Hitherto it has devoted the subscriptions and donations of its members to defraying in turn the initial expenses of each of the kitchens it has started. But now that every district in Vienna is provided with a kitchen, the association will apply its funds to purchasing the freehold of the houses which serve as kitchens. The building in the Hechtengasse is already the property of the first association. Every year, however, a certain sum, corresponding in amount to the rent of that kitchen, is set aside by the executive committee; and this, together with the other funds at their disposal, will be allowed to accrue until it be sufficient to purchase another kitchen. The rent for the two kitchens will then be set aside until enough money is raised to buy a third, and this process will continue until the association is the owner of its eight kitchens. Then every year a sum, equal to the combined rents of these kitchens, will be devoted to providing very poverty-stricken districts with food at less than cost prices, and giving free dinners to poor children.

Now that his organization for the food supply of Vienna is in full working order, Dr. Kuhn is seeking out new fields of enterprise. He has just completed an elaborate arrangement for transporting provisions to any town or village in which an outbreak of cholera should occur. Everything is to be cooked in Vienna, and taken to the plague-stricken district in air-tight cans. These cans are an invention of the doctor's own. They fit into wooden cases which are lined with felt; and food placed in them retains its heat for twenty-four hours. He is now engaged, in co-operation with the Red Cross Society, in perfecting the commissariat arrangements for the soldiers who, in case of war, would be billeted near the capital. The first association is also considering a plan for supplying with food the public hospitals and other charitable institutions in Vienna.

These people's kitchens must be ranked among the most successful philanthropic undertakings of this century. They are a striking proof of the splendid results which may be attained by individual efforts. Before Dr. Kuhn began his work, Vienna, so far at least as its poor were concerned, was the worst-fed capital in Europe; to-day it is undoubtedly the best. Thousands of men, women and children, who, if the old restaurant regime had continued, would go half starved, have now all they can eat every day of their lives. Wholesome, palatable food has, in fact, been brought within the reach of even the worst paid of wage earners; and this has been done without any lavish expenditure. The cost of starting a kitchen in which five hundred persons can dine is only some £500. It would be a hard task to find a more humane—or a wiser—way of spending money. The underfed, it is well to remember, are a dangerous element in any community.

LOCOMOTIVE INJECTORS.*

By GEORGE H. BAKER.

As the title chosen for this paper is somewhat ambiguous, it is proper to state at the outset that the treatment of the subject herein will be confined in its scope principally to questions of operation and management, and these will be considered principally as affecting the coal consumption of locomotives.

As is generally well known, the injector was invented by Henri J. Giffard, a French engineer, in 1858, and patented in the same year. Messrs. William Sellers & Co., of Philadelphia, began the manufacture of injectors in America in 1860, and the veteran locomotive builder, Mathias Baldwin, was the first to apply one to an American locomotive. For fifteen years following their introduction to this country injectors made but poor progress in supplanting pumps as a means of feeding water to locomotive boilers.

The eighth annual convention of the American Railway Master Mechanics' Association, held in this city in 1875, appointed a committee to report on the subject: "Is it economical to use injectors on locomotives, and to what extent?" This committee, reporting to the next convention, held at Philadelphia in 1876, stated that, in answer to its circulars of inquiry, 15 master mechanics, representing 1,361 locomotives, stated that of this number 508 engines had pumps and injectors, 769 had pumps and no injectors, and 22 engines had injectors and no pumps. This may be considered as showing the relative standing of pumps and injectors in the estimation of master mechanics at that time. The replies alluded to expressed the opinion also that injectors were valuable auxiliaries to pumps, but not so reliable; that they saved no fuel, and that they cost about the same as pumps to construct and maintain.

Up to this time no experiments had been made to determine the comparative merits of pumps and injectors for general locomotive service. The committee named (of which Mr. E. T. Jeffery, now president and general manager of the Denver & Rio Grande Railway, was chairman) made a carefully conducted test with a freight engine on the Illinois Central Railroad to determine the respective merits of pumps and injectors as regards reliability of action and economy of fuel. The test was made by running the engine eight trips of 128 miles each, using the pump exclusively; and the same number of trips over the same piece of road in the same service, using an injector exclusively; making a run of 1,024 miles with the pump and the same number of miles with the injector. The injector used was a No. 6 Friedman. The coal and water used by the engine during this time were carefully measured, and a record was kept of the load hauled and of the steam pressure in the boiler. The load hauled by the engine during the trial was nearly the same while using the pump and while using the injector. With the pump the load was 2·42 per cent. greater than with the injector. With the pump the engine burned 9·8 per cent. more coal and evaporated 4·28 per cent. less water per pound of coal than with the injector. The variations of boiler pressure were fewer with the injector than with the pump, and the engine made steam more freely while using the injector. After making due allowance for the delays and switching at stations, the committee decided that the use of the injector effected a saving of coal of 6·21 per cent., making no allowance for the small excess of load hauled by the engine while using the pump. The committee tested the capacity of the injector practically by a hard fast run on the road, and also while the engine was standing still in the roundhouse. During the run the injector put 21·38 gallons of water into the boiler per minute, with 114 pounds steam pressure. The supply of water was ample for the hardest work the engine could do. The standing test was made with 110 pounds boiler pressure, and the injector forced 18·19 gallons per minute into the boiler. It was found that the injection could be graduated to about half the maximum feed.

The committtee considered other phases of the use of injectors, which do not need to be mentioned here. Its final conclusions were that injectors were as reliable as pumps for feeding locomotive boilers with the tank water at normal temperature, and that a saving in fuel was effected by using the injector; the boiler pressure was kept steadier and the boiler itself was subjected to fewer changes in temperature. This report formed the basis of the movement toward the general adoption of the injector for feeding water to locomotive boilers. Within the following ten years pumps disappeared almost entirely from locomotives, and now they are a rarity. It is now generally recognized that the findings of this committee report, rendered eighteen years ago, were in the main correct, and that injectors are reliable boiler feeders, that they are economical of fuel, and that they are conducive to economy in boiler repairs.

As these two reasons—economy of fuel and economy of boiler repairs—constituted the basis of the injector's success in gaining favor and general adoption, it may be interesting to briefly analyze the reasons for its superiority to the pump in these respects. The reason for the injector reducing boiler repairs as compared with those necessary while using pumps is due to its principle of action. In the injector a jet of steam mingles with a stream of water, and, imparting its velocity and all of its heat (both sensible and latent) to the water, forces it into the boiler at temperatures ranging approximately between 200° and 300° Fah., or only about 100° below the normal working temperature of the boiler and its contents of steam and water. In using pumps, the feed water was forced into the boiler at the ordinary temperatures of water that stands in ponds and wells, ranging from 40° in winter to perhaps 80° in summer—about 300° colder than the working temperature of the boiler. Naturally this difference in the temperature of the feed water entering the boilers by the two means employed caused considerable difference in the severity of service to which the boilers were subjected. They were subjected to less variation of temperature by the hot feed water from injectors than by the cold feed water from pumps. There being less variation of temperature, there was necessarily less of the movements known as expansion and contraction of the parts of the boilers, and this prolonged the life of these parts and reduced the frequency of needed repairs.

The reason for the fuel economy effected by the substitution of injectors for pumps was also due to the facts just stated, although, perhaps, not so evidently. Why should a locomotive make steam more freely and burn less coal when its boiler is fed by an injector than when fed by a pump? The master mechanics' committee did not attempt to explain this, nor does the writer know of the explanation ever having been made. Theoretically, the injector is more efficient than the pump. In the injector the steam employed imparts all its energy of motion to the water, and when this is spent it gives up all the heat it possesses to warming the water—a most perfect application of heat to the performance of work.

Not a unit is lost except by radiation from exposed surfaces. All the heat not converted into useful work re-enters the boiler for further use. The pump was made to work by the motion of the engine, and the portion of the engine's energy absorbed by the work of the pump (though small) was no more economically utilized than the balance of the engine's energy absorbed in hauling the train. Compared with the performance of the injector, this was very wasteful. The friction of the stuffing box packing on the pump plunger absorbed some power at the expense of fuel. These items detracted from the economy of the pump, but as their influence was necessarily small, it is evident that we must look further for the real or principal reason for the injector saving coal. The pump could not be worked while the engine was standing, and the injector could be.

It was found injurious to the boiler to work the pump while the engine was running shut off down hills; therefore while using pumps the practice was to always supply the boiler with a quantity of water equivalent, or more than equivalent, to what was being used as steam. It is the belief of the writer that the reason of the injector's ability to save coal in locomotive service rests almost entirely on the fact of its frequent use while the engine is standing or running shut off. There is no other evident reason than this, and, as mentioned, the simple higher efficiency of the injector compared with the pump.

If these views are correct, it is evident that they should be generally understood, and that in service injectors should be operated so as to secure the most economical results that they are capable of effecting. Generally this is not done, and many enginemen who operate injectors do so much as they would a pump, regulating it to supply an equivalent of water to the boiler as used, and suspending injection as much as possible when the engine is not working steam. The practice is wasteful of fuel, and no good results from it. With pumps such practice was necessary for the preservation of the boiler. This may be illustrated as follows: A locomotive running some distance shut off with the pump working would apparently suffer no diminution of steam pressure until the throttle was opened, when the pressure, as shown by the gauge, would immediately fall anywhere from 20 to 60 pounds, the amount depending on the quantity of cold water that had been pumped into the boiler while the engine was running shut off. Of course, the change of temperature, accompanying so great a change of pres-

TABLE I.—PERFORMANCE OF INJECTORS IN STARTING.

INJECTOR.	No.	Temp. Feed.	Min. pressure at which injector will: Start.	Work.	Waste of water in starting. 140 lbs steam Approx.	Time lost in starting after use, as heater 140 lbs. steam. Approx.	Remarks. (Jar has no effect on any of these injectors.)
Lifting.							
A	8	65°	35	26	.15 gal.	1¼ min.	Injector starts promptly and surely. Can be started fine or coarse feed instantly. Restarts if feed is broken.
B	8½	60°	32	31	.1 "	¾ "	Same as A.
C	8	56°	40	35	.3 "	2 "	Starts promptly. It is best to start slowly to catch water.
D	8	57°	25	20	.4 "	1½ "	Starts promptly at max. or min. It is best to start slowly to catch water.
F	8	57°	35	35	.3 "	1½ "	Starts promptly. It is best to start slowly to catch water.
G	8	74°	45	40	.2 "	2 "	Is difficult to start, and is uncertain if not properly adjusted.
Non-lifting							
E	8	59°	30		1.3 "	¾ "	Starts promptly at max. or min. It is best to start slowly to catch water
H	8	67°	30	25	.9 "	¾ "	Starts promptly at max. or min. It is best to start slowly to catch water.
I	8	65°	30	20	1.5 "	1 "	Uncertain except at low pressure, and cold water. Unsuited for locomotive use.

TABLE II.—PERFORMANCE OF INJECTORS WITH VARYING TEMPERATURES OF FEED.

INJECTOR.	No.	Steam, 140 pounds. Delivery, gallons per hour. Max.	Min.	Rate.	Temperature, Fahr. Feed water.	Delivered water. Max.	Min.	Steam, 100 pounds. Delivery, gallons per hour. Max.	Min.	Rate.	Temperature, Fahr. Feed water.	Delivered water. Max.	Min.	Steam, 45 pounds. Delivery, gallons per hour. Max.	Min.	Rate.	Temperature, Fahr. Feed water.	Delivered water. Max.	Min.
Lifting.																			
A	8	1,890	1,110	41	65°	178°	185°	2,256	966	57	63°	133°	161°	1,464	510	70	68°	124°	163°
B	8½	1,800	966	46	60°	162°	218°	1,692	828	52	67°	153°	218°	696	69°	0	57°	157°	157°
C	8	1,944	1,050	47	55°	141°	195°	2,040	918	55	55°	126°	199°	1,698	690	59	59°	138°	158°
D	8	1,740	1,105	36	60°	215°	278°	1,728	936	46	58°	174°	247°	1,140	690	40	53°	138°	184°
F	8	1,980	1,300	39	56°	182°	200°	2,088	960	54	56°	144°	182°	1,338	624	53	59°	133°	162°
G	8	2,328	1,284	47	73°	175°	196°	1,980	930	53	74°	166°	191°	1,134	750	34	74°	172°	169°
Non-lifting.																			
E	8	2,046	1,176	43	60°	167°	190°	2,332	936	58	59°	137°	174°	1,314	960	27	59°	124°	131°
H	8	1,824	1,482	19	67°	164°	188°	2,050	1,35[illegible]	34	67°	140°	160°	1,470	1,086	26	68°	124°	142°
I	8	2,050	1,704	17	67°	178°	198°	2,134	1,500	30	66°	156°	180°	1,638	828	50	61°	125°	160°

* Read before the October meeting of the New York Railroad Club.—National Car Builder.

sure, caused damaging consequences to the boiler, which showed themselves in broken staybolts and leaking flues.

The cause of the apparent rapid change of pressure was due to the fact that the cold water pumped into the boiler while no steam was being used, and, consequently, when there was practically no circulation in the boiler, sank to the bottom of the boiler, by its gravity, leaving the hot water in contact with the steam at the top. Heat almost invariably travels upward. Under these conditions, the cold water could not impart its cold to the hot water above it, or mix with it, except very slowly, and neither could the hot water impart its heat downward to the cold water below, or mix with it except very slowly. This state of affairs allowed a large quantity of water to be pumped into the boiler while the engine was running shut off, without affecting the steam pressure as indicated by the gauge, even if the fire was at low heat. But immediately steam was used, either by the cylinders or the blower, circulation was established, the steam resting on the hot water was rapidly used up and the pressure as rapidly fell, so that by the time the hot and cold water became thoroughly mixed a considerable fall of pressure had taken place. The writer remembers one instance which occurred while he was employed as a fireman, in which the gauge pressure fell nearly 80 pounds within five minutes. The blow-off cock had been opened while running down a hill, and the boiler had then been filled up by both pumps. The fireman's ignorance prevented him from understanding the situation or taking steps to prevent a fall of pressure.

The steam gauge pointer stood immovable at 140 pounds. On the application of the blower the pressure fell to nearly 60 pounds. The engine had to wait injectors in present use in this country. The tests were made by a disinterested person, and in conducting them the suggestions of the makers were followed carefully, and every effort was made to secure the most satisfactory record possible for each injector. The information is given here simply to put on record some interesting data concerning injector performances, and not to help or hinder the sale of any particular make of injector, and for this reason the names of the different injectors tested are withheld, and they are merely designated alphabetically. The principles of the best kinds of an injector for locomotive service may be named, and those that seek the best can make their own selection. The diagrams show that some of the injectors in ordinary use have a wide range of adjustment, while others have a very small range of adjustment, as illustrated by A and D Fig. 1 shows graphically this quality of the different injectors, and Fig. 2 is a diagram in which the lines showing the maximum and minimum performances of the different injectors with different steam pressures are plotted in juxtaposition for easy comparison. It will be noticed that six lifting injectors were tested and three non-lifting injectors. The table and diagram give full information respecting the comparative performances of each injector, and respecting the same of the two different kinds of injectors. It has been said that "with non-lifting injectors, the feed water is nearly always delivered at a higher temperature than with the other kind." The results of the tests show that this is not true. The average temperature of delivery of the lifting injectors was found to be 194°, at 140 pounds boiler pressure; and the average temperature of the delivery of the non-lifting injectors at the same pressure was found to be 180·8°—a difference of 13·2°. The tests showed that the maximum range of action and will always declare its action and is most economical to maintain.

PENETRATION OF MODERN RIFLES.

A REPORT has been issued by the Small Arms Penetration Committee, under the presidency of Colonel T. Fraser, C.B., C.M.G., R.E., which deals with the penetration of the Lee-Metford, Mannlicher, and Martini-Henry rifles. The Lee-Metford has a 0·303 in. bore, with a bullet weighing 215 grains, sectional density 0·3346, specific gravity 10·484, and a muzzle velocity of 1,975 to 2,000 foot seconds. The bore of the Mannlicher is 0·256 in., with a bullet of 160 grains, sectional density 0·3488, specific gravity 10·404, and a muzzle velocity of 2,300 to 2,400 foot seconds. The Martini-Henry bore is 0·450 in., the weight of bullet 480 grains, sectional density 0·3386, specific gravity 10·916, and a muzzle velocity of 1,270 to 1,300 foot seconds. Cordite was used throughout the trials, the muzzle velocities showing a difference of as much as 100 foot seconds. The most remarkable difference in this respect is that recorded of the Mannlicher gun, the velocities of which fell off very considerably during the firing of 1,000 rounds, owing to the erosion of the barrel. Our own service weapon was not affected after firing as many as 3,000 rounds. The bulk of 150 rounds of Lee-Metford and Mannlicher ammunition were about the same, but the weights were 9 lb. and 7 lb. respectively. The report states that the main advantage of the Mannlicher is the greater flatness of its trajectory and consequently its greater margin of effect at decisive ranges. Thus the 6 ft. margins at 1,000 yards are for the Mannlicher 168 ft., for the Lee-Metford 156 ft., and for the Martini-Henry 82 ft. Remarking upon this, the committee state that so long as the very small bullet now in use is effective against

TABLE III.—PERFORMANCE OF INJECTORS. WITH UNVARYING TEMPERATURE OF FEED.

INJECTOR.	No.	Steam, 140 pounds.						Steam, 120 pounds.						Steam, 80 pounds.						Averages.		
		Delivery. Gallons per hour.			Temperature of water.			Delivery, Gallons per hour.			Temperature of water.			Delivery, Gallons per hour.			Temperature of water.			Delivery in per cent. of 2,200 galls. per hour.		
					Feed.	Delivered.					Feed.	Delivered.					Feed.	Delivered.				
		Max.	Min.	Rate.		Max.	Min.	Max.	Min.	Rate.		Max.	Min.	Max.	Min.	Rate.		Max.	Min.	Max.	Min.	Rate.
Lifting.																						
A	8	1,764	1,158	34	80°	196°	198°	1,956	1,056	46	80°	174°	179°	2,160	912	58	80°	151°	178°	89	47	42
B	8½	1,704	1,068	37	"	190°	237°	1,626	936	42	"	172°	232°	1,704	864	49	"	162°	223°	76	43	33
C	8	1,830	1,332	27	"	175°	205°	1,806	1,146	37	"	163°	205°	1,836	1,116	39	"	154°	197°	83	51	29
D	8	1,614	1,176	27	"	232°	279°	1,644	1,086	34	"	213°	272°	1,584	1,014	36	"	196°	251°	73	46	23
F	8	1,9*8	1,272	33	"	189°	210°	1,890	1,032	45	"	190°	206°	1,908	1,104	42	"	168°	192°	86	52	34
G	8	1,842	1,686	8	"	198°	198°	2,292	1,356	41	"	171°	197°	1,956	1,056	46	"	171°	197°	92	62	30
Non-Lifting.																						
E	8	1,854	1,266	31	"	191°	200°	2,082	1,128	46	"	169°	203°	2,112	1,020	52	"	162°	188°	92	52	40
H	8	1,854	1,554	16	"	179°	198°	1,854	1,470	21	"	166°	182°	1,998	1,326	34	"	157°	171°	86	66	20
I	8	Won't work						1,818	1,818	0	"	182°	182°	2,106	1,584	25	"	168°	187°	......	......	......

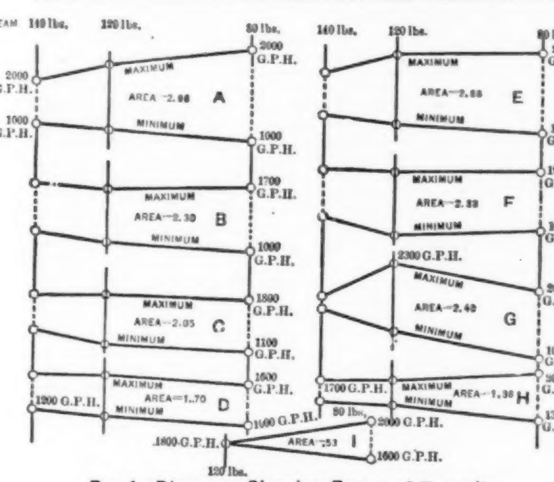
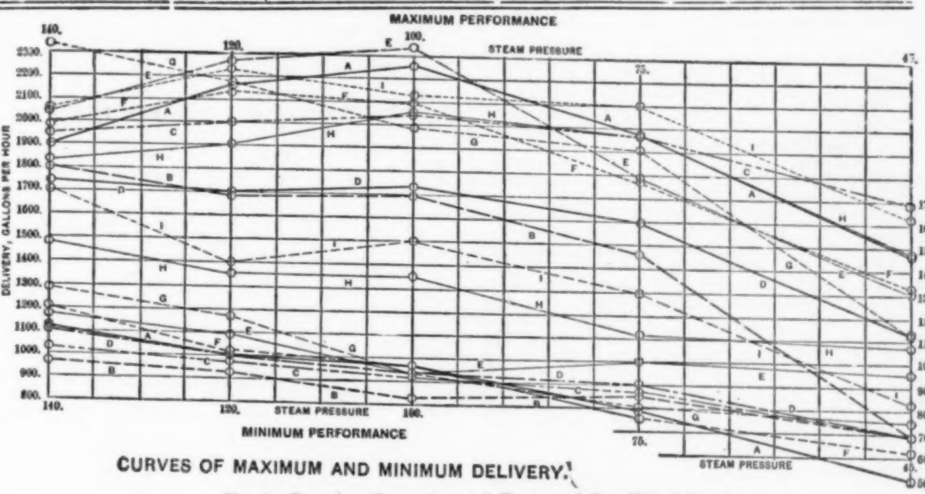


Fig. 1.—Diagrams Showing Range of Capacity.



CURVES OF MAXIMUM AND MINIMUM DELIVERY.

Fig. 2.—Showing Capacity and Range of Possible Adjustment.

awhile before being able to start the short train on a level.

The operation of the injector being entirely different from the pump, no such evil result as this follows its use when the engine is standing or running shut off. The steam used in the injector causes a constant circulation within the boiler, and any fall of temperature of its contents is immediately made manifest by a fall of pressure, shown on the gauge. The economical advantage of putting water into a locomotive boiler while the engine is idle or running shut off results from the fact that in this way the necessary rate of combustion is lowered. The fire may be kept hotter while the engine is stopping at stations, and it need not be made so hot when the engine is working hard. This equalization of the rate of combustion is highly conducive to economy of fuel. Injectors should be operated so as to replenish the boiler as much as practicable while the engine is not using steam, and should be adjusted to the finest practicable feed while the engine is working hard.

The widely variable character of a locomotive's work requires that its injectors should be of wide range of capacity and of possible adjustment. The master mechanics' committee of 1876 declared that injectors should be capable of being adjusted to one-tenth of their maximum feed. No injector was ever made that accomplished this, and the best of those in use at the present time are adjustable to only about half of their maximum feed with the same boiler pressure. This fact deserves recognition in placing injectors on locomotives, and care should be taken to have them of different capacity, so as to afford a wider range of possible adjustment of feed to suit the varying requirements of service. This is not the general practice, as it is customary to equip engines with two injectors, one on either side, and both of the same capacity. This is not the best practice, and positively and frequently leads to unnecessary consumption of coal.

The annexed tables and diagrams give the results of a series of carefully conducted tests of most of the temperature of delivery were attained by the lifting type of injector, while the maximum delivery was attained by a non-lifting injector. The tests show that injectors A, F, C, and H have high delivery and range of action, and that injectors B and D attain a high delivery temperature at the expense of range of action and maximum delivery. The non-lifting injectors are shown to have less range of action than the lifting injectors. The non-lifting injectors have high maximum capacity, but cannot be finely graduated. The deficiency in possible graduation is due in some degree to the want of a proper regulating device. Another objectionable feature of non-lifting injectors is their necessary location, which is usually out of sight of the engineer. This leads to loss of water through the overflow, which is not serious. An advantage of non-lifting injectors consists of their being below the water level of the tender, and that their supply of water will surely reach them at a colder temperature than the supply of water reaches lifting injectors. The latter having to be "primed"—having to induce their supply by a small jet of steam—the heat of this is imparted to the supply, and in some injectors this delays proper action, especially when the injector is hot from having been used as a heater or from having its action "broken." It is noticeable, however, that the restarting injectors are of the lifting type. The injectors having a closed overflow when working are objectionable in this respect. The injector may break, and the accident may not be noticed by the operator. This may lead to serious results in two ways—lowered water in the boiler and heated water in the tender. The forms of injectors that are apt to prove most economical to maintain are those in which the flow of water is most direct. Adjustments of the interior parts of injectors that cause the swiftly moving water to strike against these parts subject them to rapid wear with water that contains grit in any form.

To summarize: The best injector for locomotive service is that which has the widest range of capacity, will handle the warmest water, is most easily manipulated, troops the importance of this length of margin outweighs all other considerations. As regards accuracy of fire, when once the sighting was obtained, the Mannlicher was very good, and was rather better at 1,000 yards than the Lee-Metford. The recorded effects of the fire of the rifles named against definite objectives are very curious. The small bore rifles easily penetrated a 9 in. brick wall, with ½ in. boards at the joints, though the bricks themselves resisted the bullets. At 100 yards some of the bullets penetrated the joints of the wall and two ¾ in. deal boards. At 600 yards the bullets passed through the joints of a 4½ in. wall and 7¾ in. boards beyond, and at 400 yards bullets passed through the joints of a 14 in. wall and two ¾ in. boards. At 200 yards 200 rounds breached a 9 in. wall so that a man could get through a hole which, on measurement, proved to be 24 in. by 15 in. At the same range it took 1,028 rounds, mostly in volleys of 50, to make a smaller breech in a 14 in. wall. A wall with ⅜ in. joints of hard mortar was found to be practically impervious to the new small-bore bullets. Hence brick walls for defenses should be 9 in. thick with five joints set in cement. Sun-dried brick walls, as used in India, 18 in. thick, were found to be bullet-proof, except after continued firing. A singular fact is that in such walls the mean penetration increases gradually from 5 in., at a range of 3 yards, to 15 in. at 400 yards, and then slowly decreases. Fresh or green mud walls require to be at least 4 ft. in thickness to stop bullets at any ranges. With screens of mild steel or wrought iron, a thickness of 7-16 of an inch is required for safety, but at 60 yards a plate of hardened steel, weighing 8·75 lb. per square foot, will stop a Lee-Metford bullet. Against a Mannlicher a quarter inch plate of hardened steel is required at short distances. At 500 yards a plate of hardened steel, less than 1-10 of an inch thick, weighing only 3 lb. 10 oz. per square foot, resisted all the small-bore bullets. The committee recommend this plate for field artillery shields against musketry, if such be ever adopted, as artillery are not likely to engage infantry at ranges under 500 yards. The new small-bore rifles,

with their steel-coated bullets, were found to have much greater penetration than the Martini-Henry with its unsheathed bullet at 1,500 yards. The statement is made in the report that with the new rifles timber is no longer of any use as cover at short ranges, owing to the great thickness required. And no longer will growing timber give the protection it has hitherto. On the other hand, a much smaller quantity of timber in the form of boards, made into troughs or wooden boxes, or hurdle troughs with shingle or sand between, will completely stop the new bullets. In the absence of shingle, a few inches of the macadam of roads will supply the necessary core. As regards times of flight, the new arms are very superior to the Martini-Henry. —Arms and Explosives.

[Continued from SUPPLEMENT, No. 986, page 15761.]

MODERN DEVELOPMENTS OF HARVEY'S WORK.*

By Dr. T. LAUDER BRUNTON, F.R.S.

As a general rule, the distention of any hollow muscular organ is attended with great pain. How great is the suffering when obstruction of the bowel prevents evacuation of its contents; or when a calculus, in its passage down the gall duct or ureter, forcibly distends their wall. One of the severest tortures of the middle ages was to distend the stomach with water, and the Emperor Tiberius could imagine no more awful punishment for those whom he hated than to make them drink wine and, at the same time, by means of a ligature, to prevent the distended bladder from emptying itself. The heart is no exception to this rule, and distention of its cavities brings on most acute physical suffering. Its inability to empty itself is a question of relative, and not of absolute power; for a strong heart may be unable to work only against enormously increased resistance in the peripheral arterioles, while the heart, weakened by degeneration, may be unable to empty itself in face of pressure little, if at all, above the normal.

When the contractile power of the heart is not, as it is in health, considerably in excess of the resistance opposed to it in vessels, but only nearly equal to it, a slight increase in the resistance may greatly interfere with the power of the heart to empty itself, and bring on pain varying in amount from slight uneasiness to the most intense agony in angina pectoris. This is, indeed, what we find, for a heart whose nutrition has been weakened by disease of the arteries, and consequent imperfect supply of blood to the cardiac muscle, is unable to meet any increased resistance if this should be offered to it, and pain is at once felt. In such cases, unless they be far advanced, we find precisely as we might expect, that walking on the level usually causes no pain, but the attempt to ascend even a slight rise, by which the muscles are brought into more active exertion, brings on pain at once. Yet here again we find, as we should expect, that if the patient is able to continue walking, the pain passes off and does not return. These phenomena would be inexplicable were it not for Ludwig's observations on circulation through the muscles, but in the light of these observations everything is made perfectly intelligible. Walking on the flat, by causing no violent exertion of the muscles, produces no mechanical constriction of the vessels, and thus does not increase the blood pressure. The greater exertion of walking up a hill has this effect, but if the patient is able to continue his exertions, the increased dilatation of the vessels—a consequence of muscular activity—allows the pressure again to fall, and relieves the pain.

As muscular exertion continues and the vessels of the muscles become dilated, the flow of blood from the arteries into the veins will tend to become much more rapid than usual. The pressure in the arterial system will consequently fall; but that in the veins will become increased, and unless a corresponding dilatation occurs in the pulmonary circulation, blood will tend to accumulate in the right side of the heart, the right ventricle will be unable to empty itself completely, shortness of breath will arise, and even death may occur. At first the right side of heart is affected, and the apex beat disappears from the normal place and is felt in the epigastrium, but the left ventricle also becomes dilated, though whether this is simply through nervous influence tending to make it act concordantly with the right, or for some other reason, it is at present impossible to say. Severe exertion, even for a few minutes, may produce this condition in healthy persons,† and when the exertion is overcontinued it may lead to permanent mischief. More especially is this the case in young growing boys, and it is not merely foolish, it is wicked to insist upon boys engaging in games or contests which demand a long continued overexertion of the heart, such as enforced races and paper chases extending over several miles. Intermittent exertion, either of a single muscle or of a group of muscles, or of the whole body, appears to lead to better nutrition and increased strength and hypertrophy, but overexertion, especially if it continues, leads to impaired nutrition, weakness and atrophy. If we watch the movements of young animals, we find that they are often rapid, but fitful and irregular and varied in character, instead of being steady, regular and uniform. They are the movements of the butterfly and not of the bee. The varied plays of childhood, the gambols of the lamb, and the frisking of the colt, are all well adapted to increase the strength of the body without doing it any injury; but if the colt, instead of being allowed to frisk at his own free will, is put in harness, or ridden in races, the energy which ought to have gone to growth is used up by the work, its nutrition is affected, its powers diminished, and its life is shortened. The rules which have been arrived at by the breeders of horses ought to be carefully considered by the teachers of schools, and by the medical advisers who superintend the pupils.

In youth and middle age every organ of the body is adapted for doing more work than it is usually called upon to do. Every organ can, as it is usually termed, make a spurt if required; but as old age comes on this capacity disappears, the tissues become less elastic, the arteries become more rigid and less capable of dilating and allowing freer flow of blood to any part, whether it be the intestine, the skin, the brain, the muscles, or the heart itself. Mere rigidity of the arteries supplying the muscles of the heart will lessen the power of extra exertion, but if the vessels be not only rigid, but diminished in caliber, the muscles of the limbs and the heart itself will be unfit even for their ordinary work, and will tend to fail on the slightest overexertion. This fact was noticed by Sir Benjamin Brodie, who, when speaking of patients with degenerating and contracted arteries, such as lead to senile gangrene, said: "Such patients walk a short distance very well, but when they attempt more than this, the muscles seem to be unequal to the task, and they can walk no further. The muscles are not absolutely paralyzed, but in a state approaching to it. The cause of all this is sufficiently obvious. The lower limbs require sometimes a larger and sometimes a smaller supply of blood. During exercise a larger supply is wanted on account of the increased action of the muscles; but the arteries being ossified or obliterated, and thus incapable of dilatation, the increased supply cannot be obtained. This state of things is not peculiar to the lower limbs. Wherever muscular structures exist the same cause will produce the same effect. Dr. Jenner first, and Dr. Parry, of Bath, afterward, published observations which were supposed to prove that the disease which is usually called angina pectoris depends on ossification of the coronary arteries. . . . When the coronary arteries are in this condition, they may be capable of admitting a moderate supply of blood to the muscular structure of the heart; and as long as the patient makes no abnormal exertion, the circulation goes on well enough; when, however, the heart is excited to increased action, whether it be during a fit of passion, or in running, or walking upstairs, or lifting weights, then the ossified arteries, being incapable of expanding so as to let in the additional quantity of blood, which, under these circumstances, is required, its action stops and syncope ensues; and I say that this exactly corresponds to the sense of weakness and want of muscular power which exists in persons who have the arteries of the legs obstructed or ossified."*

But the syncope and stoppage of the heart mentioned by Brodie are not the only consequences of impaired cardiac nutrition. The heart may be still able to carry on the circulation, but the patient may suffer intense pain in the process. The outside of the heart was found by Harvey to be insensible to light touches, but the inside of the heart appears to be much more sensitive either to touch or pressure.

A knowledge of the mode of circulation of blood through the muscles enables us to understand not only the pathology of angina pectoris, but the rationale of various methods of treating patients suffering from angina pectoris or other forms of heart disease. In most cases, our object is a twofold one—to increase the power of the heart and to lessen the resistance it has to overcome. In some cases, we require also to aid the elimination of water which has so accumulated as to give rise to œdema of the cellular tissues, or dropsy of the serous cavities. In our endeavors to produce these beneficial changes in our patients, we employ regimen, diet and drugs, and it is evident that as in one case the condition of a patient's heart may be very different indeed from that in another, the regimen which may be useful to one may be fatal to the other. We have already seen that sudden and violent exertion may raise the blood pressure, and so lead to intense cardiac pain or to stoppage of the heart and instant death; while more gentle exercises, by increasing the circulation through the muscles, may lessen the pressure and give relief to the heart.

The methods of increasing the muscular circulation may be roughly divided into three, according as the patient lies, stands, or walks. First, absolute rest in bed with massage;† second, graduated movements of the muscles of the limbs and body while the patient stands still; third, graduated exercises in walking and climbing.

The second of these methods has been specially worked out by the brothers Schott, of Nauheim, and the third is generally connected with the name of Oertel. It is obvious that in cases of heart disease where the failure is great and the patient is unable even to stand, much less to walk, where breathlessness is extreme and dropsy is present or is advanced, the second and third methods of treatment are inapplicable. It is in such cases that the method of absolute rest in bed, not allowing the patient to rise for any purpose whatever, hardly allowing him to feed himself or turn himself in bed, proves advantageous. The appetite is usually small, the digestion imperfect, and flatulence troublesome; and here an absolute milk diet, like that usually employed in typhoid fever, is often most serviceable, being easily taken and easily digested, while the milk sugar itself has a diuretic action, and tends to reduce dropsy. But while simple rest prevents the risk of increased arterial tension and consequent opposition to the cardiac contractions which might arise from muscular exertion, such benefits as would accrue from muscular exertion and increased circulation would be lost were it not that they can be supplied artificially by massage. This plan of treatment, although it has only recently been revived, was known to Harvey, who narrates the case of a man who, in consequence of an injury—of an affront which he could not revenge—was so overcome with hatred, spite, and passion that "he fell into a strange disorder, suffering from extreme compression and pain in the heart and breast, from which he only received some little relief at last when the whole of his chest was pummeled by a strong man, as the baker kneads dough."‡

This was a very rough form of massage, but the same kneading movements which Harvey described have been elaborated into a complete system, more especially by Ling in Sweden, and made widely known in America and this country by Weir-Mitchell and Playfair. One might naturally expect that kneading the muscles would increase the circulation through them in somewhat the same way as active exercise, but to the best of my knowledge, no actual experiments existed to prove this, and I accordingly requested my friend and assistant, Dr. Tunnicliffe, to test the matter experimentally. The method employed was, in the main, the same as that devised by Ludwig, and employed by Sadler and Gaskell under his direction. The results were that during the kneading of a muscle the amount of venous blood which issued from it was sometimes diminished and sometimes increased; that just after the kneading was over the flow was diminished, apparently from the blood accumulating in the muscle, and this diminution was again succeeded by a greatly increased flow exactly corresponding to that observed by Ludwig and his scholars.

The clinical results are precisely what one would expect from increased circulation in muscles, and cases apparently hopeless sometimes recover most wonderfully under this treatment. For patients who are stronger, so that confinement to bed is unnecessary, and who yet are unable to take walking exercise, Schott's treatment is most useful, and it may be used as an adjunct to the later stages of the treatment just described, or as a sequel to it. Here the patient is made to go through various exercises of the arms, legs, and trunk with a certain amount of resistance, which is applied either by the patient himself setting in action the opposing muscles or by an attendant who gently resists every movement made by the patient, but graduates his resistance so as not to cause the least hurry in breathing or the least oppression of the heart. Perhaps the easiest way of employing graduated resistance is by the ergostat of Gartner, which is simply an adaptation of the labor crank of prisons, where the number of turns of a wheel can be regulated in each minute, and the resistance which is applied by a brake may be graduated to an ounce. The objection to it is the uniformity of movement and its wearisome monotony. Oertel's plan of gradually walking day by day up a steeper and steeper incline, and thus training the muscles of the heart, is well adapted for stronger persons, but when applied injudiciously may lead, just like hasty or excessive exertion, to serious or fatal results. In Schott's method stimulation of the skin by baths is used as an adjunct, and this may tend to slow the pulse, as already mentioned. But in all these plans the essence of treatment is the derivation of blood through a new channel, that of the muscular vessels, and the results in relieving cardiac distress and pain may be described in the same words which Harvey employs in reference to diseases of the circulation: "How speedily some of these diseases that are even reputed incurable are remedied and dispelled as if by enchantment."*

There is yet another consequence of the circulation to which Harvey has called attention, although only very briefly, which has now become of the utmost importance, and this is the admixture of blood from various parts of the body. After describing the intestinal veins, Harvey says: "The blood returning by these veins and bringing the cruder juices along with it, on the one hand from the stomach, where they are thin, watery, and not yet perfectly chylified; on the other thick and more earthy, as derived from the feces, but all pouring into this splenic branch, are duly tempered by the admixture of contraries."†

Harvey's chemical expressions are crude, for chemistry as a science only began to exist about a century and a half after Harvey's death, yet the general idea which he expresses in the words which I have just quoted is wonderfully near the truth.

Two of the most important constituents of the blood are chloride of sodium and water. Chloride of sodium is a neutral salt, but, during digestion, both it and water are decomposed in the gastric glands, and hydrochloric acid is poured into the stomach, while a corresponding amount of soda is returned into the blood, whose alkalinity increases pari passu with the acidity of the stomach. Part of this alkali is excreted in the urine, so that the urine during digestion is often neutral or alkaline. Possibly some of it passes out through the liver in the bile, through the pancreas and intestinal glands into the intestine, where, again mixing with the acid chyle from the stomach, neutralization takes place, so that neutral and comparatively inactive chloride of sodium is again formed from the union of active alkali and acid. But it is most probable that what occurs in the stomach occurs also in the other glands, and that it is not merely excess of alkali resulting from gastric digestion which is poured out by the liver, pancreas and intestine, but that these glands also decompose salts, pour the alkali out through the ducts, and return the acid into the blood.

We are now leaving the region of definite fact and passing into that of fancy, but the fancies are not entirely baseless, and may show in what directions we may search out and study the secrets of nature by way of experiment. For what is apparently certain in regard to the decomposition of chloride of sodium in the stomach, and probably in the case of neutral salts in the pancreas and intestine, is also probable in that important though as yet very imperfectly known class of bodies which are known as zymogens. Just as we have in the stomach an inactive salt, so we have also an inactive pepsinogen, which, like the salt, is split up in the gastric glands, and active pepsine is poured into the stomach. But is the pepsine the only active substance produced? Has no other body, resulting from decomposition of the pepsinogen, been poured into the blood while the pepsine passed into the stomach? Has the inactive pepsinogen not been split up into two bodies active when apart, inactive when combined? May it not be fitly compared, as I have said elsewhere, to a cup or glass, harmless while whole, but yielding sharp and even dangerous splinters when broken, although these may again be united into a harmless whole?‡

This question at present we cannot answer, but in the pancreas there is an indication that something of the kind takes place, for Lepine has discovered that while this gland pours into the intestine a ferment, which converts starch into sugar, it pours through the lymphatics into the blood another ferment which destroys sugar. Whether a similar occurrence takes place in regard to its other ferments in the pancreas, or in the glands of the intestine, we do not know, nor do we yet know whether the same process goes on in

* The Harveian Oration, delivered at the Royal College of Physicians, on October 18, by Dr. T. Lauder Brunton, F.R.S.—Nature.

† Schott, Verhandl. des IX. Congresses in Med. zu Wien, 1890.

* "Lectures on Pathology and Surgery." By Sir Benjamin Brodie. (London, 1846, p. 360.)

† Practitioner, vol. li., p. 190.

‡ "The Works of William Harvey," Sydenham Society's edition, p. 128.

* "The Works of William Harvey," Sydenham Society's edition, p. 141.

† Ibid., p. 75.

‡ Practitioner, vol. xxxv., August, 1885.

the skin, and whether the secretion of sweat, which is usually looked upon as its sole function, bears really a relationship to cutaneous activity similar to that which the secretion of bile bears to the functions of the liver. There are indications that such is the case, for when the skin is varnished, not only does the temperature of the animal rapidly sink, but congestion occurs in the internal organs, and dropsy takes place in serous cavities, while in extensive burns of the skin rapid disintegration of the blood corpuscles occurs. It is obvious that if this idea be at all correct, a complete revolution will be required in the views we have been accustomed to entertain regarding the action of many medicines. In the case of purgatives and diaphoretics, for example, we have looked mainly at the secretions poured out after their administration for an explanation of their usefulness, whereas it may be that the main part of the benefit that they produce is not by the substances liberated through the secretions they cause, but by those returned from the intestine and skin into the circulating blood.

How important an effect the excessive admixture of the juices from one part of the animal body with the circulating blood might have was shown in the most striking way by Wooldridge. He found that the juice of the thyroid gland, though it is harmless while it remains in the gland, and is probably useful when it enters the blood in small quantities in the ordinary course of daily life, yet if injected into the blood, will cause it to coagulate almost instantaneously, and kill the animal as quickly as a rifle bullet. What is powerful for harm is, likewise, powerful for good in these cases, and the administration of thyroid juice in cases of myxœdema is one of the most remarkable therapeutic discoveries of modern times. Since the introduction by Corvisart of pepsine as a remedy in dyspepsia, digestive ferments have been largely employed to assist the stomach and intestine in the performance of their functions, but very little has been done until lately in the way of modifying tissue changes in the body by the introduction of ferments derived from solid organs. For ages back savages have eaten the raw hearts and other organs of the animals which they have killed, or the enemies they have conquered, under the belief that they would thereby obtain increased vigor or courage; but the first definite attempt to cure a disease by supplying a ferment from a solid non-glandular organ of the body was, I believe, made in Harvey's own hospital by the use of raw meat in diabetes.* It was not, however, until Brown-Sequard recommended the use of testicular extract that the attention of the profession became attracted to the use of extracts of solid organs. Since then extract of thyroid, extract of kidney, extract of supra-renal capsule, have been employed; but even yet they are only upon their trial, and the limits of their utility have not yet been definitely ascertained.

But yet another therapeutic method has been recently introduced which bids fair to be of the utmost importance, the treatment of disease by antitoxins. The discovery by Pasteur of the dependence of many diseases upon the presence of minute organisms may be ranked with that of Harvey, both in regard to the far-reaching benefits which it has conferred upon mankind and for the simplicity of its origin. The germ of all his discoveries was the attempt to answer the apparently useless question: "Why does a crystal of tartaric acid sometimes crystallize in one form and sometimes in another?" From this germ sprung his discovery of the nature of yeast and of those microbes which originate fermentation, putrefaction and disease. These minute organisms, far removed from man as they are in their structure and place in nature, appear in some respects to resemble him in the processes of their growth and nutrition. They seem, indeed, to have the power of splitting up inactive bodies into substances having a great physiological or chemical activity. From grape sugar, which is comparatively inert, they produce carbonic acid and alcohol, both of which have a powerful physiological action. From inert albumen they produce albumoses having a most powerful toxic action, and to the poisonous properties of these substances attention was for awhile alone directed. But it would appear that at the same time they produce poisons they also form antidotes, and when cultivated without the body, and introduced into the living organism, they give rise to the production of these antidotes in still greater quantity.

The plan of protection from infective diseases, which was first employed by Jenner in smallpox, is now being extended to many other diseases and the protective substances which are formed in the body, and their mode of action, are being carefully investigated. The introduction either of pathogenic microbes or of toxic products appears to excite in the body a process of tissue change by which antitoxins are produced, and these may be employed either for the purpose of protection or cure. By the use of antitoxins tetanus and diphtheria appear to be deprived of much of their terrible power. But it seems probable that a similar result may be obtained by the introduction of certain tissue juices into the general circulation. It was shown by Wooldridge that thyroid juice has a power of destroying anthrax poison, and it seems probable that increase of the circulation of certain organs will increase their tissue activity, will throw their juices or the products of their functional activity into the general circulation, and thus influence the invasion or progress of disease. As I have already mentioned, we are able to influence the circulation in muscles both by voluntary exertion and by passive massage, and we should expect that both of these measures would influence the constituents of the blood generally; and such indeed appears to be the case, for J. K. Mitchell † has found that after massage the number of blood corpuscles in the circulation is very considerably increased.

Had time allowed it, I had intended to discuss the modifications of the heart and vessels by the introduction of remedies into the circulation, the power of drugs to slow or strengthen, to quicken or weaken the power of the heart, to contract or relax the arterioles, to raise or lower the blood pressure, to relieve pain or to remove dropsy; but to do this would require time far exceeding that of a single lecture. Moreover, the methods and results were admirably expounded to the College by Dr. Leech in his Croonian lecture, and I have therefore thought I should be better fulfilling the wish of Harvey that the orator of the year should exhort the fellows and members of the College to search out the secrets of nature by way of experiment by directing their attention to fields of research which have received at present little attention, but promise results of great practical value. Lastly, I have to exhort you to continue in mutual love and affection among yourselves; and it seems to me that the best way of doing this is to direct your attention to the examples of Harvey and of our late president, whose death we deplore to-day. They were beloved by their fellows while they lived, their loss was lamented when they died, and they have left behind them an example not only of goodness, but of courage. Harvey, seated speechless in his chair, distributing rings and parting gifts to his friends while awaiting the approach of death; or Andrew Clark, steadfastly determining to continue at work and die in harness, in spite of the hæmoptysis which seemed to threaten a speedy death, afford us noble examples which ought to encourage us to follow the directions of the venerable Longfellow, who, taking the organ Harvey studied to symbolize such courage as Harvey and Clark showed, says—

"Let us then be up and doing
With a heart for any fate,
Still achieving, still pursuing,
Learn to labor and to wait."

* Brit. Med. Journ., February 21, 1874, p. 221 et seq.

† American Journal of Medical Science, May, 1894.

REMOVAL OF LARGE NUMBERS OF NAILS, ETC., FROM THE STOMACH BY GASTROTOMY—RECOVERY.*

By A. W. MAYO ROBSON, F.R.C.S. Eng., Senior Surgeon, Leeds General Infirmary; Professor of Surgery in the Victoria University; Member of the Council of the Royal College of Surgeons of England.

THE following case seems worthy of record, not only on account of its extraordinary nature, but because of the result of the treatment adopted. For the history I am indebted to my friend Dr. Collier, with whom I saw the patient.

A thin, pale and apparently intelligent girl ten years of age was seen by Dr. Collier on July 1, 1894, on account of gradual failure of health and loss of flesh, with sickness and vomiting, the vomiting only having come on for the first time the previous day. The vomiting persisted in spite of treatment, and the abdominal pain was at times extremely severe. At first the vomited matter consisted of thin mucus, with black specks of altered blood, but later much more blood was ejected. The patient gave no clew to the nature of her illness and bore her pain with great fortitude. She rapidly wasted and became attenuated to an extreme degree, as she was unable to take or retain any food.

On August 4 the first indication of the cause of her illness presented itself, as she vomited a garden nail $1\frac{5}{8}$ in. in length, and on being questioned confessed to having swallowed five others. Examination of the abdomen revealed several hard masses in the left iliac region, which it was thought might be the nails in question enveloped in scybalous masses, but no tumor could be felt in the region of the stomach. On the 8th I saw the patient in consultation with Dr. Collier, and as the vomited matter contained so much blood it was thought that other nails must be present in the stomach causing irritation; hence we considered that it would be advisable to perform gastrotomy. With the assistance of Dr. Collier, Dr. Buchanan and Mr. Stanley Collier, I opened the abdomen above the umbilicus by a $2\frac{1}{2}$ in. incision in the course of the linea alba, when exploration with the finger revealed a hard mass lying at the back of the abdomen on the left of the spine, evidently within the stomach. On opening the stomach by an inch vertical incision the finger detected a large quantity of hardware, which was removed by means of forceps, the stomach at the end of the operation being apparently completely emptied. The foreign bodies consisted of forty-two cast iron garden nails $1\frac{5}{8}$ in. long, ninety-three brass and tin tacks from $\frac{1}{2}$ in. to 1 in. long, twelve large nails, some brass-headed, three collar studs, one safety pin and one sewing needle. The index finger was passed through the pylorus, and it was thought that one or more nails could be felt, but as Dr Buchanan, who was administering the anæsthetic, said the pulse was exceedingly feeble—in fact, scarcely perceptible—it was felt desirable to bring the operation to a conclusion as quickly as possible.

The opening in the abdomen was, therefore, closed by a continuous silk suture, which included all the coats, after which the serous surfaces were apposed by several Lembert's stitches, the parietal wound being brought together by a continuous suture for the peritoneum and aponeurosis and interrupted silkworm gut stitches for the skin. During the operation soiling of the peritoneum was prevented by sponge packing and by the edges of the stomach being held forward by forceps. Before commencing the operation the patient's pulse was rapid, and the child seemed ill fitted to bear a serious operation, but when she had been put into bed from the operating table, the pulse was hardly perceptible. I therefore transfused several ounces of warm saline fluid, with immediate relief, and before leaving the house the pulse was 130 and distinctly perceptible. She was fed entirely by enemata for a week, and afterward with soft and liquid food for some time. The day after the operation she vomited a small pin; on the following day three garden nails and two tacks, these probably having come from the duodenum; and on the third day a feather was vomited. After the fourteenth—i. e., the sixth day after operation—there was no more vomiting, and the patient began to regain strength. From the 10th to the 31st there were passed per anum at different times, embedded in hard fæcal matter, thirty garden nails, a piece of a needle, one stud, eight tacks and a J pen. The wound healed by first intention, and there was no distension, rise of temperature or other untoward symptom throughout the convalescence. On September 3, Dr. Collier wrote to me that, although the patient was very thin, she was taking food and was going out for walking exercise. After recovery, the patient confessed to having begun to swallow nails as far back as Christmas, 1893, so that some of them must have been in the stomach and intestines for at least eight months.

From a subsequent letter in October I fear that, although well so far as the operation is concerned, the little patient retains her morbid appetite. Although gastrotomy is an ancient operation, there are, according to Greig Smith, only thirteen, or possibly fourteen, well authenticated cases recorded, these being given in the tables of Crede and Richardson and Bernays. With the exception of one fatal case reported in the Lancet of August 21, 1894, I can find no other like this in the number and character of the objects removed. In the work on abdominal surgery previously referred to, the conditions mentioned as calling for gastrotomy are: (1) The presence of a foreign body in the stomach of such a nature that we know it cannot be passed except at great risk, and (2) the existence of serious and urgent symptoms. To these I would add a third, viz., the presence of a number of irritating foreign bodies which, though possibly capable of being passed individually, produce so much irritation collectively that their removal per vias naturales cannot be waited for. Under the third category would come the case here related. The following points are worth noting: 1. The curiously morbid appetite, amounting to monomania, in an apparently sane and intelligent child. 2. The obscurity of the symptoms until a clew was obtained by the vomited nail. 3. The recovery of the patient, although the lining of the stomach seemed so much injured by the foreign bodies, and although the child was so reduced at the time of operation. 4. The marked effect of transfusion of saline solution in combating shock, although no blood had been lost at the time of operation. The practical lesson to be derived from the above is that even in desperate cases, such as the one related, where the patient was reduced to a condition of the most extreme weakness, it may be worth while, though apparently hopeless, to make an attempt to save life.—The Lancet.

* A paper read before the Leeds and West Riding Medico-Chirurgical Society, October 19, 1894.

PROLONGING LIFE.

THE desire to live long is a perfectly natural feeling. Ambitious hopes and centenarian proclivities are commendable in the aged and laudable even in the young. In all records of longevity, in all histories of centenarianism that have been written, and in all investigations of a scientific character that have been made, there is no mention of a man of one hundred years or upward having committed suicide. The longer people live the longer they wish to live. Some writers on the subject endeavor to prove that centenarians are like poets, born—not made. On the other side, there is just as much argument and evidence to prove the contrary. William Shakespeare seems to have been born a poet, but there is no testimony tending to show that the gift was hereditary. And when the enemies of longevity write upon this topic, they always attempt to make it appear that some really exceptional qualities were inherited by the lucky individual from his parents or ancestors and give him very little credit for his own good traits. Of course, a good constitution and regular habits in early life are much to start with in the race, but many people so endowed do not reach ninety years of age, even.

Women seem to have an advantage over men in long living. Statistics recently collected by Professor Humphry, of England, in his work on "Old Age," show that, as usual, in records of longevity the women preponderate over the men in spite of many disadvantages they have to contend with, such as the danger incidental to child-bearing and diseases associated therewith. He attributes this to the comparative immunity of woman from many exposures and risks to which man is subject. Temperance in eating and drinking, also freedom from anxieties in reference to labor and business, are on the side of the female sex. No woman writer has yet taken up the subject, I believe; which seem odd, as female physicians are now a necessity of modern times. It has been often stated, as is probably true, that the principal authors on the subject of longevity have been physicians, who as a rule do not reach the standard in age of the average man. In some of its aspects nothing seems to be more capricious and eccentric than the law in regard to longevity. First-born children and also those born out of wedlock were formerly believed to be more likely to live longer than any other. The offspring of centenarians, if they would only intermarry with their class, might in time surpass all other people in length of years.

Poor people, too, were classed as favored in this respect, and we find Sir William Temple stating that health and long life were usually the blessings of the poor. Now the tables prepared by Dr. Humphry afford many curious facts bearing on this subject in Great Britain. Most men of one hundred years and over were of medium height, though the well-known and generous Jew, Sir Moses Montefiore, was six feet three inches, and lived to the age of 102 years. Nearly one-fourth of the 824 cases reported by Dr. Humphry, in which the persons had arrived at eighty or a hundred years, were first born children, one-half of these of easy, placid dispositions, not given to worrying and fretting about things, not anxious to reform the world, and about one-third poor people. They do not have a monopoly of long life, however, for a little over half of the 824 were persons in comfortable circumstances. In this same collection, one-third were small eaters, about two-thirds moderate eaters, and only one-tenth large eaters. As for marriage having any effect on women, it seems that the unmarried ones have as good a chance as the married. Some writers think that marriage, on the contrary, has a tendency to make men live longer, though it may not affect women. Hahnemann, the founder of the homeopathic school of medicine, married at 80, and was an active worker and enjoyer of life up to 90. The late Sir Henry Holland excelled in horsemanship at 84.

Exercise of a physical character, and also intellectual occupations, contribute to give variety to life and promote longevity, though one should be careful not to indulge in excesses in either line of recreation. Commonly received opinions are to the effect that centenarians have few pleasures. Sarah White, a widow, who died at 101, at Pershore, is reported by Dr. Smith, in his letter to Professor Humphry, to have danced

and sung on her 101st birthday anniversary. Her digestion and appetite were good, and it saddens the social philosopher to think that if Sarah had not indulged in this terpsichorean revelry she might have lived many years longer. She was an early riser, like almost all centenarians, drank beer occasionally (that probably was the cause of the dancing), but did not smoke or take snuff.—William Kinnear, North American Review.

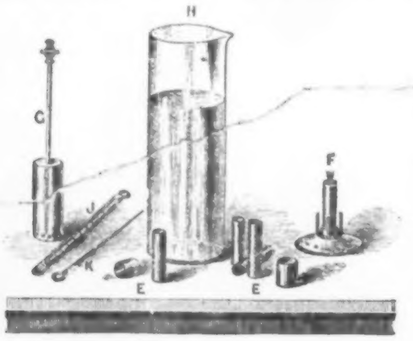
CALORIMETER FOR TESTING COAL.

COMPARISONS of evaporative tests, obtained with different classes of fuel, are of little practical use unless the precise value of the fuel employed in each case is known. Hitherto there has been too much of the rough and ready character in connection with the comparisons of evaporative tests, though we are pleased to note, in connection with modern boiler trials, the importance of accuracy in observation and measurement, not only as to the quantity of water evaporated and coal consumed, but also with respect to the quality of the fuel, and the constitution of the gases is now much more fully recognized.

The use of the calorimeter or other apparatus for determining the exact heating power of a fuel is now much more general. Its services are of importance, not only in connection with boiler tests, but also for determining the efficiency of various classes of fuel. There are several varieties of calorimeter, and we illustrate herewith the one known as Thompson's, which has been largely adopted by railway, colliery, and steamship companies, and is a favorite with many engineers and chemists on account of the reliability of its results and the ease and rapidity with which they may be obtained.

CALORIMETER IN ACTION.

The principles upon which Thompson's calorimeter or coal-testing apparatus are based are—first, that the latent heat of steam is equal to 967 deg. Fah.; and secondly, that coal or other fuel burned in pure oxygen evolves the same amount of heat as when perfectly consumed in atmospheric air. The experiment is made thus: A measured weight of fuel is finely powdered, dried, and intimately mixed with a proportionate weight of a mixture consisting of chlorate and nitrate of potash, and is placed in a small copper furnace primed with a fuse, as shown at F, covered with the cylindrical combustion vessel, G. and immersed in a given weight of water contained in the glass jar, H. After a few seconds the fuse ignites the mixture of coal and potash, and the products of combustion, passing through the water in a finely-divided state, communicate the whole of the heat to the water. The temperature of the water is duly noted at the commencement and end of the experiment, and it is only necessary to multiply the weight of the water by the number of degrees of heat communicated to the water to have the calorific value of the fuel in calories. The evaporative duty—that is, the amount of water capable of being converted into steam per pound of fuel burnt—is directly as the elevation of temperature. Thus, if the thermometer showed a rise of 7·5 deg., then 1 lb. of fuel would evaporate 7·5 lb. of water.—The Practical Engineer.

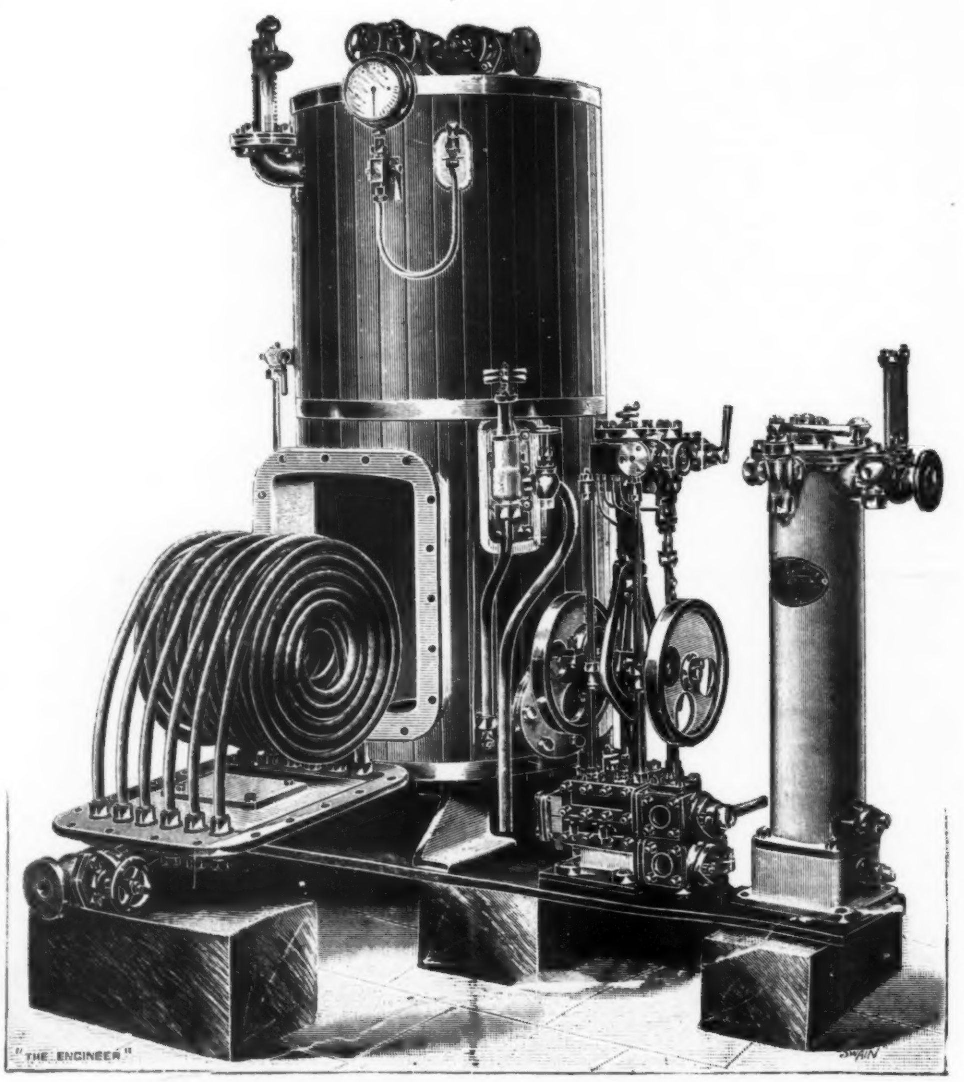


THE COMPACTUM EVAPORATOR AND DISTILLER.

WE have recently had an opportunity, says the Engineer, London, of inspecting a complete evaporating and distilling plant, such as is being fitted in vessels of the torpedo destroyer class, and which is entitled to some notice on the score of efficiency, light weight and general compactness—a combination especially valuable in these small engine rooms.

Our illustration shows the plant as designed and manufactured by Messrs. John Kirkaldy, Limited, West India Dock Road. About this plant the following figures are of interest: The total weight of the plant, with water at requisite height, is only 1,841 lb., disposed as follows: Evaporator, 1,180 lb.; pump, 206 lb.; distiller, 120 lb.; water, 330 lb.; the necessary spare gear would add 134 lb., bringing up the entire total to 1,975 lb. The height is 5 ft. 11 in.; greatest width, 4 ft. 4 in.; and depth, 2 ft. 9 in. When it is borne in mind that the "feed makeup" produced is 10 tons per diem, and that produced for drinking purposes another two tons, the weight of this machine for these outputs seems strikingly low, and shows how much Mr. Kirkaldy has achieved by constant and careful improvements.

It is not many years since Mr. Kirkaldy put into practice his ideas concerning the importance of heating feed water by methods which kept the water free from oil and other impurities, whether the heat for the purpose were obtained by exhaust or by live steam, and he proved that the latter might often be used with advantages which, under some circumstances, became economical advantages. For a long time the use of live steam for this purpose was derided, but now the advantages are generally acknowledged, and Mr. Kirkaldy's methods and apparatus widely employed.



THE COMPACTUM EVAPORATOR AND DISTILLER.

The successful working of some feed heaters and makeup feed evaporators has only been achieved by minute attention and special devices, which long experience and new inventions have made possible, and there are probably no manufacturers who have done so much in initiating and developing these now indispensable adjuncts to the high pressure marine engine as the one to whose works we now refer. It is not only for the supply of water for potable purposes on board ship that evaporator or distiller plant is used, but for the much larger supply for boilers, which could not now be worked without this means of supply. Previous to the manufacture of the compact apparatus made by Mr. Kirkaldy, the space required for plant for so large a supply would have prohibited its use. The employment of these feed heaters supplied with live steam and placed between the feed pump and the boiler has afforded most important aid to economical marine engine working. Live and exhaust steam feed heaters and various forms of condensers are made on the Kirkaldy system for electric light stations, and for many places where the possible life of boilers is now, in consequence, much greater than would have been possible with high pressures without such aids.

THE DUSTING PROCESS.

By H. H. BUCKWALTER.

HAVE you ever tried making pictures by the "dusting" process? If you have not, you have missed one of the easiest and most fascinating processes in photography. Contrary to most other methods, its cost is almost nominal, while the range of application embraces some results not obtainable by any other method except at considerable cost and requiring much practice and ability.

The process consists of forming an image in an adhesive substance whose "stickiness" varies with the lights and shadows in the negative. After the substance is properly printed upon, a powder of almost any sort or color is dusted on the image, and is caught and retained in varying proportion as the light affected the original coating. Bichromate of ammonia is the sensitizing substance, and the adhesive mixture is composed of gum arabic and glucose. After the image is properly "developed" in the powder forming the picture, it may be removed from its original support and transferred to another, and, if the powder is suitable, the image may be burned into porcelain or metal and form the most durable photograph possible to obtain.

The sensitive solution is not affected by light while in a liquid state, but it is possibly advisable to keep it on the darkroom shelf, or at least away from direct sunshine. While an ironclad formula is not imperative, the following is suitable:

Water, hot	3 ounces.
Powdered gum arabic	75 grains.
Glucose	1 even teaspoonful.
Ammonium bichromate,	2 drachms, dissolved in ½ ounce of water.

Mix thoroughly in the order named. The glucose is generally so thick and difficult to handle that it is impossible to give a certain proportion by weight. After the whole has been thoroughly dissolved, the solution should be filtered through paper, and every precaution taken to avoid dust. About the only possibilities of failure lie in dust and air bubbles in coating the plate, so the operations should be conducted accordingly.

Thoroughly clean a glass plate—an old negative glass will do. After drying the plate, the solution may be poured on in similar manner to flowing collodion. A thin, even coat is desired, but the thickness does not make much difference, except in convenience in drying. After coating, the plate should be dried at once. The writer's method consists in moving rapidly over a gasoline stove and keeping the plate constantly in motion in every direction, and almost horizontal, to avoid drying in streaks. There is no danger from frilling. This operation should be conducted by lamplight or very subdued daylight, for as soon as the plate is dry it is considerably more sensitive than silvered paper.

After the film is dry the plate may be kept for a few days, but preferably, should be printed at once.

The whole operation of coating and drying should not consume more than from three to five minutes, and, therefore, very little can be gained by coating in advance, while some advantage is apparent from freshly coated plates.

Almost any good negative of medium density may be used. One with transparent detail in high lights will give excellent results in most subjects. The sensitized plate is placed in the frame under the negative in the usual way and printed in direct sunshine for from forty-five seconds to one minute; in shade or diffused light, a proportionally longer time. By electric arc light, from five to eight minutes at a distance of two feet will probably be about correct, but most operators will use sunshine in preference. After printing, the plate is taken from the frame in subdued light, and a small quantity of powder is dusted upon it. For experiment, a fine bronze will answer very well, in fact, it is preferable for most subjects. With a camel's hair duster or tuft of cotton the powder is moved around over the plate. If it does not adhere properly, the image can be "developed" by breathing on the film and gently dusting the powder over the spots breathed upon.

After the whole image is up, a small amount of "doctoring" can be done. Too much local density can be remedied by gently rubbing with a piece of soft chamois, while weak portions may be brought up by a proper application of breath followed by powder.

Contrary to other photographic processes, a "reversed negative" is obtained by the above method of printing. But this is capable of giving exceedingly pretty effects in statuary and similar subjects, and even in some landscapes the effect is good.

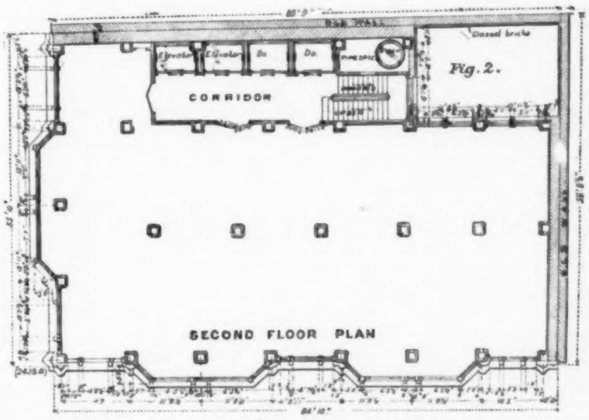
Immediately after "development" the plate should be flowed with collodion, either plain or "leather," the latter containing a small percentage of castor oil. As soon as the collodion coating has set, the plate should be immersed in clean water, in a tray, and the yellow color soaked away. Several changes of water will effect this, and make the image permanent, in fact after thorough washing, the glucose film will be removed entirely and the image will then consist entirely of the powder with a coating of collodion.

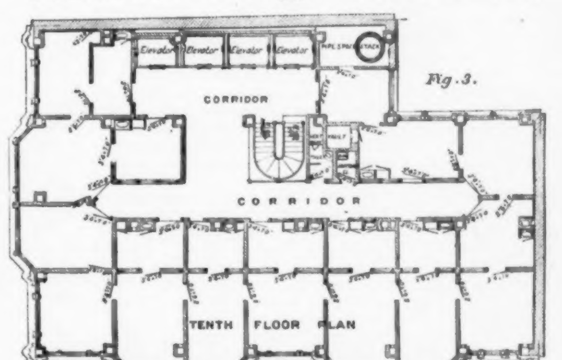
After the yellow color has been removed, the plate may be dried and a black varnish flowed over the back or a piece of black paper placed in the same position. This will answer very well where the image is formed from a plain negative. If a positive is used to print from, the image will then be developed into a gold statue (for example) on a background of black or the color of the mount. Any other color can be used, of course, instead of the gold bronze. The color of the background will depend on subsequent operations if plain glass is undesirable.

Now, about transferring. If thick flexible (leather) collodion is flowed over the plate, just previous to removing the yellow color, and the operation carefully conducted, the whole film may be removed from the glass and placed on another support. The removal of the film may be facilitated by scratching away a narrow border around the edge of the plate, thus allowing the water to get under the collodion and freely dissolve away the glucose layer. Then the whole film may be gently pushed from the glass, and a piece of porcelain or other support may be slipped under the film, which may be placed where wanted, and the whole removed from the water. A piece of hard, clean blotter is then placed on the film, and all the water carefully rolled out.

If the final support is porcelain or light colored celluloid, the image may be developed up with lamp black, powdered charcoal, insoluble Prussian blue or similar powders. Any powder insoluble in water will answer. For burning in porcelain, special powders give the best results. They may be obtained in almost any color from dealers in artists' materials. For black, however, lampblack will generally answer.

While the writer has never had occasion to try the process on lantern slides, the method seems to suggest some possible advantages. The amateur may consider it superior on account of the cost, for if one print is ruined or defective, it can be removed and the glass at once coated without much expense. For the decoration of lamp shades, paper weights or similar articles, few other processes bear comparison in any way, for nearly all are limited as to color and delicate in their manipulation.—The Photo-American.





THE RELIANCE BUILDING, CHICAGO.

THE RELIANCE BUILDING, CHICAGO.

BUT little has as yet been published in Europe concerning the lofty office buildings which are so characteristic a feature of the larger American cities, and this has led our London contemporary, Engineering, to give the following interesting description of one of the most recently erected examples. The Reliance building, the subject of our notice, is situated on the southwest corner of Washington and State Streets, Chicago, the site measuring 55 ft. on State Street by 85 ft. on Washington Street. There had been a five story building on this site of very heavy masonry construction, the lower floor of which had been used for a bank. The leases of the upper floors expired May 1, 1894. In 1890 plans were made for a 16 story building, and the foundations and first story of this new building were then put in, the upper four stories of the old building being held up on screws while the first story of the new building was slipped in under them. The original plans were somewhat revised this past spring and the building changed to 14 stories, as shown on Fig. 1.

On May 1, 1894, the old building was taken down to the second floor, and the new building is being erected from the second floor up. The tenants of the first floor and basement—a dry goods firm—remain in their store and keep it open for business during the period of construction. Subsequently to putting in the first story, the owner of the ground and building, Mr. W. E. Hale, sold the ground to Otto Young for $480,000, and leased it back immediately for 198 years at $24,000 a year, 5 per cent. of the purchase price. Mr. Hale is putting up the new building, and Mr. J. H. Gray, C.E., of Chicago, is the engineer responsible for the ironwork.

The building being very narrow compared with the height, viz., 55 ft. wide and 200 ft. high, especial attention has been given to designing the framework, which is of steel, and which carries the outer walls of the building. For wind bracing, instead of tension rods, which had been used heretofore, it was determined to put plate girders 24 in. deep at each floor between the outside columns, thus binding the columns together and transferring the wind strain from story to story on the table leg principle. These plate girders are bolted to the face of the column, and form a perfectly rigid connection with the column. The columns are in two story lengths, and adjoining columns break joints at each floor. Every piece of iron in the construction, including all the roof beams, is thoroughly fireproofed, with porous fireproofing. Each piece of fireproofing around the column is wired to the column with copper wire.

The exterior of the building is white enameled terra cotta and plate glass. The windows were made as large as the situation of the columns would allow, and the position of these was fixed by the fact that they had to correspond with the columns of the old building, and so are not as well arranged as they might otherwise have been. The interior of the building will be the most elaborately finished of any building in Chicago. The woodwork is of the finest mahogany; the floors are marble mosaic; the halls above the second floor are white Italian marbles, and in the first and second floors colored marbles. The general plans of a couple of these floors are shown in Figs. 2 and 3, while the arrangement of the steel girders will be best understood from Fig. 4.

The Z bar column, with its horizontal cap plates breaking the column in two at every story, was discarded in this building, and a new column used, composed of eight angles. The cast iron columns, so dear to our British architects, have been abandoned in all good work in the States, and have led to the design of many different types of columns built from rolled sections of steel. Special attention is paid to the question of making easy connections between the girders and these columns, and for most purposes standard connections are used—a plan which favors cheapness of construction. A favorite type of column for office buildings has been the Z bar column mentioned above. The column which has replaced this form in the new building is the design of Mr. Gray, and consists of a number of angles riveted together. A large number of tests on full-sized specimens have been made at the Keystone Bridge Works with perfectly satisfactory results, and from these it has been found that for all sizes of column the safe load can be taken to be $\left(17{,}100-57\frac{l}{r}\right)$ lb. per square in., where l is the length and r the radius of gyration of the column, the ends of which are taken as fixed. The ends of this column were planed off and connected by means of vertical splice plates. A clause in the specification will show the requirements in this particular, which is as follows: "The columns will be made in two story lengths, alternate columns being jointed at each story. Sections of materials are to be designated on the drawings. The quality of material will be as hereinafter specified. The column splice will come above the floor, as shown on the drawings. No cap plates will be used. The ends of the columns will be faced at right angles to the longitudinal axis of the column, and the greatest care must be used in making this work exact. The columns will be connected one to the other by vertical splice plates, sizes of which, with number of rivets, are shown on the drawings. The holes for these splice plates in the bottom of the column shall be punched ⅛ in. small. After the splice plates are riveted to the top of the column, the top column shall be put in place and the holes reamed, using the splice plates as templates. The connections of joists or girders to columns will be standard wherever such joists or girders are at right angles to connecting face of column. Where connection is oblique, special or typical detail will be shown on the drawings."

This column also being open from top to bottom, admits of putting the pipes in the corners of the column, and inclosing them with the fireproofing surrounding the latter. There is ample space for this. The connections of the plate girders to these columns are standard in nearly every instance.

The system of plumbing used in the Reliance building is the Durham. In this all the vertical risers, wastes, vents, and downspouts are of wrought iron pipe, coated inside and outside while hot with coal tar varnish. All pipes above 1¼ in. in diameter are lap welded, and all are fitted together with screw joints. All pipes for carrying sewage in the ground under the building are of light cast iron, cast in 12 ft. lengths, coated inside and outside by the same process employed in coating water pipe, and put together with lead joints. The depth of the basement brings its floor much below the level of the sewer in the street, and also necessitates sub-drainage under the basement floor, which is ordinary agricultural tile surrounded by broken stone inclosed in a light box frame of wood to keep it in position and alignment. This subsoil water, together with the waste from the fixtures in the basement, water closets and lavatories, and also from all lavatories throughout the building, with the exception of those in main toilet rooms on the seventh floor and lavatories adjoining the pipe space, flows to a pair of Shone ejectors of fifty gallons capacity each, placed below the basement floor, and thence it is pumped into the sewer in the street. The wastes from all toilet rooms, together with lavatories adjoining the pipe space, are taken down in a separate stack and connected direct with the street sewer, as is likewise done with the pipe taking away the roof water. All fittings for the pipes carrying wastes are of cast iron, threaded, and properly coated. When used on a pipe laid to a grade, this grade is cast on. All changes in direction are made with curved and Y fittings. Hand holes or rodding holes are provided in abundance, and in the toilet rooms all fixtures are set away from the wall about 18 in. to allow working room behind them in case of stoppages, thus obviating the necessity of taking down marble partitions or backs, and tearing up the floor.

As the pressure maintained in the city water mains will not raise water much above the second floor, it becomes necessary to pump the water for the remaining floors. A small pump, 10 in. by 6 in., is placed in the basement, and takes its supply from the large tank, fed direct from the city mains, and raises the water to two boiler iron tanks placed in the attic, and having a capacity of 1,000 gallons each. From these tanks it is distributed to the different points required. A large hot water heater, situated in the basement, is also fed by these tanks, and the hot water is carried back to the attic before being distributed, so as to avoid pumping. The circulation is maintained by cross connecting the hot water boiler with the foot of each hot water riser. All water pipes are of galvanized iron. As, with few exceptions, these waste, ventilating, hot and cold water pipes are located in the angles of the channels forming the columns, there is grouped in each column a complete system of plumbing, and in placing fixtures for the use of offices, long horizontal runs are avoided, and repairs reduced to a minimum. All fixtures in the rooms are set without casing, the exposed connections being of polished brass. All pipes are filled with water and carefully examined for leaks before being cased in the columns.

In the basement of this building are to be placed two high pressure boilers of 100 horse power each, which will furnish steam for all the necessary pumping and steam heating. The building is to be heated throughout by direct radiation supplied on the low pressure overhead system. The main riser is 8 in. in diameter and passes up the pipe shaft to the attic,

where it is distributed to the risers which pass back down the columns, single risers being used to supply radiators and return water of condensation. All distributors in the attic are laid at a grade of not less than 1 ft. in 20 ft., and the foot of all risers are connected into a return system to the basement. The bottom of the 8 in. main riser rests on a masonry foundation, so that its expansion shall be upward throughout its entire length. The risers, which are to be inclosed in the fireproofing surrounding columns, are to be fastened firmly to floor beams at third, seventh, and twelfth floors, so that expansion shall be in both directions from these points. On each distributing riser an expansion joint is to be set at the fourth and eighth floors. This expansion joint is to be placed just above the radiator connection. In order to have free access to these expansion joints, easily removable wooden panels are placed in the columns in front. This arrangement admits of easy inspection, and avoids the necessity of tearing down the fireproof when repairs are necessary.

In fixing upon the sizes of connections of radiators with risers, a 1 in. pipe was to supply not more than 30 square ft., a $1\frac{1}{4}$ in. pipe was to supply not more than 60 square ft. and a $1\frac{1}{2}$ in. pipe was to supply not more than 120 square ft. The square feet of radiating surface of radiators varies on each floor, gradually reducing from the lower floor upward, its greatest area being 1108 square ft. and its smallest area 738 square ft. All radiators are provided with an automatic electric temperature regulating system, complete with thermostats, etc. They are to be of the hot water pattern, having the loops connected on top as well as bottom, and each being supplied with an automatic air valve.

The specifications for the structural metal work are pretty stringent, as the following extracts from the specification show:

"Quality of Material.—The steel may be made either by the Bessemer or open hearth process. It must be uniform in quality, and must not contain over 0·10 of one per cent. of phosphorus. The steel shall have an ultimate strength of 60,000 lb. per square in. and shall not vary from this more than 4,000 lb. per square in. either way. It shall have an elastic limit of not less than one-half the ultimate strength, an elongation of not less than 25 per cent. in 8 in., and a reduction of area of not less than 45 per cent. at point of fracture. All blooms, billets, or slabs shall be examined for surface defects, flaws, or blowholes, before rolling into finished sections, and such chipping and alterations made as will insure perfect solidity in the rolled sections. A test from the finished metal will be required, representing each blow or cast; in case the blows or casts from which the blooms, slabs, or billets in any reheating furnace charge are taken, have been tested, a test representing the furnace heat will be required, and must conform to the requirements as heretofore enumerated. A duplicate test from each blow or cast and furnace heat will be required and it must stand bending 180 deg. over a mandrel the diameter of which is equal to one and a half times the original thickness of the specimens, without showing signs of rupture either on convex or concave side of curve. After being heated to a dark cherry and quenched in water 100 deg. Fah., must stand bending as before. The original blow or cast number must be stamped on each ingot from said blow or cast, and this same number, together with the furnace heat number, must be stamped on each piece of the finished material from said blow, cast or furnace heat. No steel beam or angle shall be heated in a forge or other fire after being rolled, but shall be worked cold unless subsequently annealed.

"Rivet Steel.—Steel for rivets throughout this structure shall have an ultimate tensile strength of not less than 56,000 lb. nor more than 62,000 lb. per square in., an elastic limit of not less than 30,000 lb. per square in., an elongation of not less than 25 per cent. in 8 in., and a reduction of area at point of fracture of at least 50 per cent. Specimens from the original bar must stand bending 180 deg. and close down on itself without sign of fracture on convex side of curve. Specimens must stand cold hammering to one-third its original thickness without flaying or cracking, and stand quenching as heretofore specified for rolled specimens.

"Wrought Iron.—Where wrought iron is required by plans and specifications, it shall be tough, fibrous, and uniform in quality. It shall have an elastic limit of not less than 26,000 lb. per square in. It shall be thoroughly welded during the rolling, and free from injurious seams, blisters, buckles, cinders, or imperfect edges. When tested in small specimens the iron in no case shall show an ultimate tensile strength of less than 50,000 lb. per square in. and shall have an elongation of 18 per cent. in 8 in. The same sized specimens taken from angle and other shaped irons shall have an ultimate strength of not less than 50,000 lb. per square in. and shall elongate 15 per cent. in 8 in. All iron and specimens from plate, angle, and shape iron must bend cold for about 90 deg. to a curve whose diameter is not over twice the thickness of the piece, without showing fracture. When nicked on one side and bent by a blow from a sledge, the fracture must be nearly all fibrous, showing but few crystalline specks.

"Cast Iron.—Cast iron shall be the best quality of metal for the purpose. Castings shall be clean and free from defects of every kind, boldly filleted at the angles, and the arrises sharp and perfect. Cast iron must stand the following test: A bar 1 in. square, 5 ft. long, 4 ft. 6 in. between bearings, shall support a center load of 550 lb. without sign of fracture."

"THE ELECTRIC LADY."

IN the early years of the eighteenth century, while Du Fay and the Abbe Nollet watched with astonishment "the first sparks that were ever drawn from the living body," and long before Kruger had conceived the idea of electro-therapeutics, or Kratzenstein had given that idea form, electrical phenomena, says the Lancet, were attracting much attention. Many earnest experimenters were investigating the "thing" which, since the days of Gilbert, had come to be called "electricity;" philosophers were gaining a first insight into its possibilities; a new science was quietly winning its way. At the same time the less serious portion of the society of the period, aware of the newly discovered phenomena, was amusing itself by "drawing sparks" as "electric rain," or "the electric star," or perhaps, occasionally, in the form of the "electric kiss." At the end of the nineteenth century electrical science has made an amazing progress—a progress, however, with which its more frivolous developments seem scarcely to have kept pace. They have, it is true, got beyond the stage of the frictional machine, but it cannot be said that the entertaining young man of the period yet knows how to conjure playfully with currents of "Teslaic" frequency or to amuse an audience by a skillful adaptation of the Hertzian wave. The "penny shocker" is, from the electrical standpoint, a painfully coarse experience of a coil current, and even the "electric lady" of these latter days is, on the whole, a very poor thing. "She is found to be so highly charged with animal electricity that when she immerses her hand in water any one placing a finger in the bowl at the same time experiences a shock." About the latter there can be no question; the sensation is that of an unmistakable induction current. Neither is it to be denied that she is "charged with electricity." In other words she is connected with one pole of a large coil kept carefully out of sight and hearing. She places her hand in water; a second person, standing "to earth," and doing the same, offers a passage to the current through the body, and a fall of potential is the result; but there is no obvious means of completing the circuit. This may surprise those who work only with the ordinary medical coil, but any one accustomed to larger coils and to so-called "idle pole" work, is aware that under such circumstances no metallic connection with the other pole is necessary. The circuit is completed via the body of the second person through the ground and so back to the second pole; and the more effectively the latter is "earthed," the more palpable will be the effects in question. This unpolar method is from its medical aspect something more than a mere experiment. It affords a very serviceable method of electrization. If a person lightly insulated and holding an ordinary moistened electrode attached to one pole of the secondary of a large coil be touched on the forehead by a person standing "to earth,' the former will experience a not unpleasant electrical sensation—an effect, however, scarcely perceptible on the arm. But if the "operator" places his foot upon the firegrate (thus making a better earth), the effect is stronger. If, however, the idle pole itself be well "earthed" by being connected to a gas or water pipe, then, if the person holding the electrode as above be insulated on glass and be touched as before on the arm, a distinct effect just short of muscular contraction is produced. By altering the amount of the insulation and varying the "earthing" of either pole a variety of electrical effects are obtainable. Muscular contractions of a widely varying strength and cutaneous stimulation of every degree of intensity may be thus secured.

ON SOME MAGNETIC CHARACTERISTICS OF IRIDIUM.*

By S. H. BRACKETT.

THIS paper does not claim to present all the characteristics of iridium in its magnetic relations, or to discuss the facts to which attention is called, but merely to state some points of interest which seem not to have been noted before, and which suggest reason for further investigation. The work here alluded to was done in intervals of busy elementary science teaching, and may be made more complete when further opportunity occurs.

Iridium was not left out of the list of substances so carefully examined by Faraday, and is mentioned by him as being very slightly diamagnetic. Iridium, as at present manufactured, may be presumed to differ from that used by Faraday, and in the absence of analysis of the specimens here tested, there is to be allowed a presumption that they are not pure; but the manufacturer, Mr. John Holland, is authority for saying they are more than 98 per cent. pure, with some platinum, a trace of phosphorus and no iron, and no iron has been employed in manipulation.

The first bar tested with such results as to excite further interest in the subject was 13·3 mm. long, 3·2 mm. wide, and 0·9 mm. thick. It was one of several different substances being tested for small amounts of magnetism or diamagnetism. A large electromagnet of portative force of about 5,000 grammes per square centimeter of surface was furnished with soft iron pole pieces, shaped so as to furnish a very strong field of force. When the bar of iridium was brought near the poles it was strongly attracted sidewise, and could not be made to stand radially. It acquired a permanent transverse polarity so strong as to appear to be a permanent diamagnet. Its extremely small thickness rendered test of attraction and repulsion inoperative.

In the field of any ordinary magnet it everywhere set itself at right angles to the lines of force, and when suspended by a fiber under a glass, it readily assumed the east and west position. In a place where H is determined as 0·158, its period of oscillation was 18·7 seconds, as compared with a steel bar of the same length and weight, whose period in the same place was 5·3 seconds, so that the ratio of its intensity of magnetism to that of steel was nearly as 1 to 12.

It was very difficult to magnetize it longitudinally by the ordinary stroking methods, which were likely to leave it in a very heterogeneous condition, so that it might take a position oblique to the lines of force.

To make further investigation and to determine some of its properties quantitatively, a bar was procured of Mr. Holland, 25·7 mm. long and 3·3 mm. square, weighing 3·57 grammes. Apparatus was constructed suitable to the size of this bar, and careful tests were made of its permeability, which was found to be practically unity. Whether the bar had been previously magnetized or had had nearly all magnetism removed by heating, no change of strength of current produced any perceptible change of the lines of force. Even striking it forcibly while it was in the coil failed to produce any magnetism by induction, and it could only be magnetized by actual contact with a magnet and then jarring it.

On placing it axially between the soft iron pole pieces of the magnet, and using successively currents of different strength, striking the pole pieces each time, different degrees of magnetic intensity were given to it, and on plotting the magnetization as ordinates and the current as abscisses, a curve was obtained similar to those usually made of permeability.

This bar, as well as the other, is much more readily magnetized transversely than longitudinally. It has only to be placed between flat pole pieces, so as to be in a uniform field of force, and jarred vigorously. A steel bar of the same size, tempered glass hard, cannot be magnetized transversely when subjected to the same conditions.

When attempts had been made to magnetize it longitudinally, as mentioned above, discrepancies between its magnetic moment at different trials and that obtained by transverse polarity led to further examination of the distribution of its magnetism. The field around it was platted by means of a little steel magnet 2·5 mm. long, suspended by a cocoon fiber, and the distribution was found to be very irregular. To see if a more uniform distribution could be secured, a method was devised which might be called octuple touch. Stroking was done on all four sides of the bar at once, from the middle to each end. The iridium was held by a small clamp in the center of the space between the poles of the magnet, held only by its center. Four soft iron levers were hinged so that their ends would grasp the iridium near the clamp on one side of it, and four similar levers did the same on the other side of the clamp. These sets of levers were laid on the poles of the magnet, so that when the latter was excited the levers became the real poles of the magnet. When they were applied the circuit was closed, and the sets of levers were held tightly against the magnet, and pulled off in opposite directions at the same time. By this means much better results were obtained, but the distribution was still somewhat irregular, representing the four sides of the magnet.

When magnetized transversely the field of force is much more regular, and it was feasible to delineate this field by sifting filings through a handkerchief on very thin paraffined paper, fixing them by warming and then photographing.

Very low permeability and great coercitive force, with a high intensity of magnetization, are plainly exhibited by these specimens of iridium, and these characteristics are consistent with the known physical properties of the substance.

*From the Physical Review.

THE KONISCOPE.*

By Dr. J. G. MCPHERSON, F.R.S.E., Lecturer on Meteorology in the University of St. Andrew's.

MR. JOHN AITKEN, F.R.S., has just given us the results of some careful observations on color phenomena connected with cloudy condensation, and an account of his new instrument, for detecting the impure state of the air in rooms by means of color alone, may be interesting to readers of Knowledge. No more painstaking or persevering physicist lives than the discoverer of the now acknowledged theory of the formation of dew. He has elucidated the formation of fog particles by the attraction of dust for water vapor, and has enumerated the particles of dust in a cubic inch of air, and this is another example of his assiduity and success.

If steam be blown into the air inside a glass vessel, the cloudy condensation will in time undergo a change. Of course, the dust particles in the air have seized hold of the water vapor of the steam to form visible steam particles, each dust atom forming a free surface for the adherence of the moisture. Particles fall and leave the upper part clearer, and particles fall to the bottom also. Yet the principal cause of the thinning change is in the smaller particles becoming absorbed by the larger ones. The smaller drops begin to lose their accumulated moisture, while the larger ones are still increasing in size, growing at the expense of the gradually diminishing smaller ones. In the end a comparatively small number of drops have absorbed the moisture which was previously distributed over a vast number of particles. The larger particles have devoured the smaller, and inanimate cloud particles have been struggling for "the survival of the fittest."

Steam escaping into the air has been observed to be colored when seen against the sun. Sometimes in that case the sun appears like silver (light blue), blue or green. Mr. Lockyer saw the sun look vivid green through the steam of a little paddle boat on Lake Windermere. Though the shadow of an ordinary steam jet on a white screen is nearly colorless, yet when it is electrified the shadow becomes of a dark orange-brown color.

In studying the subject, Mr. Aitken has inclosed the steam jets in tubes. For a jet from a nozzle of one millimeter bore, a tube of seven centimeters diameter and about fifty centimeters long is employed. The steam nozzle should be placed outside the tube and a little to one side, so that the eye can be brought into a line with the axis of the cylinder. This is a beautiful experiment. When the amount of steam, dust, and other conditions are properly proportioned, the colors seen through the tube are very attractive. With ordinary condensation the color varies from a fine green to lovely blues of different depths. The pale blues equal any sky blue, while the deeper blues are finer than the dark blues seen in the sky, as they have none of the cold hardness of the dark sky blues, but have a peculiar softness and fullness of colors.

Suppose now the tube is fitted up pointing to a clouded sky, and that the steam jet, under slight pressure, is blowing through it. If the exit end of the tube be open, very little color is visible; but if the end of the tube be partially closed with a glass plate to prevent a draught, the tube looks as if filled with a transparent colored gas. The first decided color is generally green, then blue of different shades.

If, now, the number of the dust particles in the tube be increased, or the pressure of the steam be increased so as to command some negligent dust particles to seize the moisture and add to the number of cloud particles, thereby making the steam more dense, then the color seen through the tube also changes. If the color was green, it now becomes deep blue; and if the ordinary condensation gave blue, the dense condensation (a strange but unavoidable connection of words) produces a dark yellowish brown. But between the blue and the yellow there is always an intermediate stage, when all color disappears and the light is simply very

* From Knowledge.

much darkened. Condensation of the denser kind may be also produced by passing a flash of electricity through the jet, by a supply of cold air, or by placing an obstruction in front of the nozzle; for there are five ways of producing a denser form of condensation of steam.

From this it is seen that the color produced by the small drops of water depends on the size of the drops, and the depth of color on their number. The most probable explanation of these color phenomena is that they are produced in the same way as the colors in plates, somewhat after the manner Newton thought the color of the sky was produced. The order of succession of the colors in thin plates is the same as in these condensation phenomena. As no white follows the first blue, it seems probable that the first order of colors is not observed; that the two generally seen are the second and third.

These color phenomena placed in Mr. Aitken's hands an easy and simple way of estimating, in a rough but useful way, the number of dust particles in the air of our rooms, and sanitary officers might with advantage employ the convenient apparatus. And Mr. Aitkin invented the koniscope for the purpose. Konis is the Greek for dust, and skopeo means "I see;" so the instrument is for detecting the quantity of dust in air by sight—in fact, by the color observed in the fog produced in the air by artificial means.

The instrument consists of an air pump and a metal tube with glass ends (about the size of the one above described in the experiments). Near one end of the test tube is a passage by which it communicates with the air pump, and near the other end is attached a stopcock for admitting the air to be tested. Wet blotting paper is attached to the inside, to make more uniform the field of color. The instrument is not nearly so accurate as the dust counter, but it is cheaper, more easily wrought, and more handy for quick work. All the grades of blue, from what is scarcely visible to deep black-blue, are attached alongside the tube on pieces of colored glass, and opposite these colors are the numbers of dust particles in the cubic centimeter of the similar air, as determined by the dust counter. While the number of particles was counted by means of the dust counter, the depth of blue given by the koniscope was noted, and the piece of glass of that exact depth of blue attached. A metal tube was fitted up vertically in the room in such a way that it could be raised to any desired height into the impure air near the ceiling, so that supplies of air of different degrees of impurity might be obtained. To produce the impurity, the gas was lit and kept burning during the experiments. The air was drawn down through the pipe by means of the air pump of the koniscope, and it passed through the measuring apparatus of the dust counter on its way to the koniscope. It may be remarked that by a stroke of the air pump attached to the koniscope, the air within the test tube is rarefied and the dust particles seize the moisture in the supersaturated air to form fog particles; through this fog the color is observed, and the shade of color determines the number of dust particles in the air. When by the dust counter the number of dust particles in a cubic centimeter of the air examined amounted to 50,000, the koniscope indicated that color was just visible; when 80,000 were counted, the depth of color was said to be "very pale blue;" when 500,000, "pale blue;" when 1,500,000, "fine blue;" when 2,500,000, "deep blue;" and when 4,000,000, "very deep blue."

When making a sanitary inspection, the pure air should be examined first, and the color corresponding to that should be considered as the normal health color. Any increase from the depth would indicate that the air was being gradually contaminated, and the amount of increase in the depth of color would indicate the amount of increase of pollution. Mr. Aitken thinks that the koniscope will be serviceable for sanitary inspectors for investigating questions of ventilation in rooms lighted with gas, and for other purposes.

As an illustration of what this instrument can detect, he gives this experiment to show how the pollution taking place in rooms by open flames may be traced. The room in which the tests were made was 24 by 17 by 13 feet. The air was examined before the gas was lighted, and the color in the test tube was very faint, indicating a clear atmosphere. In all parts of the room this was found the same. A small tube was attached to the test tube, open at the other end, for taking air from different parts of the room. Three jets of gas were then lit in the center of the room, and observations at once begun with the koniscope. Within thirty-five seconds of striking the match to light the gas the products of combustion had extended to the end of the room. This was indicated by the color in the koniscope suddenly becoming of a deep blue. In four minutes the deep blue producing air was got at a distance of two feet from the ceiling. In ten minutes there was strong evidence of the pollution all through the room. In thirty minutes the impurity at nine feet from the floor was very great, the color being an intensely deep blue.

The wide range of the indications of the instrument, from pure white to nearly black-blue, makes the estimate of the impurity very easily taken with it, and as there are few parts to get out of order, it is hoped it may come into general use for sanitary work. Mr. Aitken was quite enchanted with the beautiful colors in his preliminary experiments, but he is even more pleased at the practical benefit which the koniscope may effect when thoroughly adjusted and intelligently used.

RECENT EXPLORATION IN BRITISH NEW GUINEA.

AT the ordinary monthly meeting of the Royal Geographical Society of Queensland, on August 20, the president, Mr. J. P. Thomson, read a paper on recent exploration in British New Guinea.

The following extracts are reprinted from the Brisbane Courier:

For nearly half a century it had been known to geographers that several rivers existed in the neighborhood of the Papuan Gulf. The Aird, especially, was noticed by the officers of H. M. S. Fly some forty-seven years ago, and more recently several channels were opened by Mr. Theodore Bevan, whose investigations in British New Guinea were chiefly confined to this part of the country. Although these were nothing more than superficial surveys of a mere coastal fringe of the Gulf district, they were the means of drawing attention to an exceedingly interesting and important part of the possession.

Here we are made acquainted with a tract of country north of the Fly estuary, cut up by almost bewildering labyrinths of tidal channels that constitute the mouths of several important rivers, which traverse enormous areas of rich agricultural as well as low, swampy land. To intending settlers in British New Guinea this easily accessible region offers many inducements not readily met with in other parts of the possession. Ample facilities for inland communication exist in several of the deep-water channels along the coast, while the recently explored Purari River flows through a region possessed of many attractive features of hilly and mountainous country. Along most of the watercourses native villages are thickly scattered, and these are inhabited by numerous tribes of powerful and warlike natives, who on several occasions have opposed the friendly advances of Europeans with formidable hostility. The houses, too, are truly remarkable for their large dimensions and massive architectural structure; dwellings of from 300 ft. to 400 ft. in length and over 100 ft. high being by no means uncommon. Next to the Fly the Purari is the largest river in the possession. It enters the sea by several large channels. In the inland reaches above tidal influence it traverses some rough, hilly country, flowing almost parallel to and skirting the base of a mountain range 1,500 ft. to 2,500 ft. above sea level.

This river was explored by Sir W. McGregor in January and December, 1893. Its average width is about 250 yards. To the north lie a range of mountains 3,000 ft. to 4,000 ft. high, and southerly the country is greatly broken up by low rugged hills. To the westward the main range is visible at a distance of from fifteen to twenty miles, with its bold serrated perpendicular peaks. There is very little flat land here between the hills and the mountain spurs, although sago palms are more numerous than in some parts of the country lower down the river. The geological formation consists of sandstone associated with nodules of gray limestone. At the Aure junction, some eighty miles from the sea, the Purari receives its first considerable tributary. The width of this branch is from 80 to 100 yards, with a depth of one to two fathoms. Above its junction with the tributary the Purari maintains a general course along the main mountain range, the southern spurs of which it skirts very closely. Here the general character of the country, on the south side of the river, is a continuous succession of low sandstone hills, little more than 800 ft. high. These are rugged and precipitous, covered by dense forest. There are, however, no large trees. There was no appearance of any permanent native occupation in this district, and owing to its rugged nature the country did not seem adapted for European settlement.

Several specks of gold were found in the bed of the river, and an important discovery of coal was also made near the island of Abukiru, in the main channel of the Purari River. As it is thought that the presence of coal in this district may greatly influence the future of the country, it has been proposed to arrange for a detailed examination of the locality. The people are bronze colored, a few being lighter than the Port Moresby natives, and all lighter than those of the Purari delta. West of the Purari delta, between the mouths of the Fly and Aird Rivers, lie three important streams—the Omati, Turama and Bamu. These traverse enormous areas of low-lying country. Concerning each of these rivers, Mr. Thomson gave some interesting details, the result of Sir William McGregor's explorations.

Continuing, he remarked: "The exploration of the lower Bamu basin, besides throwing a flood of light upon a hitherto unknown part of the country, reveals to us a condition of things not easily understood, and rarely met with in any other district of the possession. Here no cultivated areas were seen, although the soil is exceedingly rich and abundantly watered. The people appeared to live entirely on sago. Bananas were growing wild among the rank forest vegetation, but there were no signs of sugar cane or sweet potatoes. A fair idea of the richness of the land in this district may be obtained when it is stated that there is nothing to be compared with it in the Fly basin within 400 miles of the sea. It is high and dry and in every respect eminently suitable for extensive and systematic cultivation, there being a much larger area of good available agricultural land than Sir W. McGregor had 'seen elsewhere in the possession.' This district could no doubt be thrown open to European settlement without in any way infringing existing native rights."

Mr. Thomson then dealt with some of the newly discovered features on the northeast coast of the possession examined by Sir William McGregor during the months of February and March last. "Recent detailed examination of some hitherto unexplored parts of the coast line," said the writer, "has discovered the existence of several navigable streams of considerable importance, while a traverse of the coastal section between Ipote and Dako shows that there are numerous sheltered channels among many coral islands along the shore of the bay. These will be available for trading crafts in all kinds of weather. Passing on from this part of the coast line, an examination was made of the mouth of a stream slightly north of the Clyde River, within the German territory. From observations of ten pairs of meridian stars the latitude of this stream was found to be 7° 58' 30" S., taken at the place where it enters the sea. It is a comparatively small watercourse, forty or fifty yards wide on the lower reaches.

"The natives here are of a dark bronze color and quite naked. The hair is worn in ringlets and removed from the face. Their ornaments consist of Job's tears, earrings of turtle shell and head ruffs of cassowary feathers. They were armed with spears of palmwood, Gothic shaped shields nearly three feet long and stone clubs. At first they were friendly, but afterward appeared hostile. The next river to claim attention is called the Mambare. This is simply one of the mouths of a river known as the Clyde, of the Admiralty charts. It lies about two miles within the British territory, and in the lower part traverses some good alluvial land, abounding with remarkably fine fields of sago palms. The river was navigable by the steam launch for the first forty miles, when further progress was impeded by rapids, and some few miles farther the channel is simply a succession of deep pools. Below the rapids some extensive areas of very fine alluvial land were met with, and the forest trees so high that the birds on the upper branches bade defiance to the marksman's firearms. Above the rapids the country was broken, and little agricultural land was to be seen. The district possesses a very fine climate. Sandflies and mosquitoes were entirely absent, and the early morning atmosphere was decidedly cool and bracing.

"The people have well-cleared and cultivated gardens, in which they plant taro, sugar cane, edible hibiscus, yams and bananas; but there were apparently no tobacco, papaya, nor pumpkins. Several villages were located on the banks of the river, some of which are situated in the midst of beautiful groves of cocoanut and betel palms. The only ornamental shrubs met with consisted of a remarkably fine variety of light yellow crotons of great beauty. Ordinary watercresses were met with at one of the villages, but they were seen at no other place on the northeast coast. The men were profusely ornamented with shells, pigs' teeth, Job's tears, cassowary feathers, red seeds and bones. Some of the women wore a necklace or two, others a narrow matwork belt, but they were clothed with nothing else. In this part of the country they use the password 'Orokaiva,' meaning 'man of peace.' They use an adz of basalt. Their pottery is not well prepared. It is without ornament, thick, and slightly conical in shape. The people seemed to be industrious agriculturists, growing food for the entire population. They possess a great number of canoes. Sir William McGregor is of opinion that some good agricultural land could be obtained for European settlement without interfering with native occupation, and he further believes that the natives would welcome European settlers who would be prepared to treat them fairly."

The next place visited was a small sluggish river, fifty to sixty yards wide and two fathoms deep, called the Ope or Opera. The position of its mouth was found to be lat. 8° 18' 16" S. and long. 148° 11' 25" E. It is convenient for watering ships and of value to traders. Several villages were seen in the neighborhood, and there was evidence of a large population of friendly natives. The men were nude, but the women were covered by a petticoat of native cloth. They were armed with spears and stone clubs, ornamented with wreaths of convolvulus and red hibiscus. They danced, sang and shouted, but appeared to be very friendly. To the south of this district the Kumusi River flows into Holnicot or Gona Bay, in lat. 8° 28' S. and long. 148° 16' E. The mouth is obstructed by a bar, some four feet below the surface. Most of the land on the lower part of this river is low and unfit for European cultivation, although considerable areas of alluvial deposits are occupied by many native gardens, and there are fine fields of sago palms. The highest point reached was about forty-six miles from the sea, by traverse, or lat. 8° 35' S. and long. 148° 0' 20" E., where further progress was barred by rapids. Here the country "was without exception the most attractive" Sir W. McGregor had "seen in New Guinea." Extensive tracts of splendid alluvial land stretched far and wide along the river valley, covered by forest trees, and to all appearances above the reach of flood. These flats occupy what was formerly the river bed, as indicated by the sandy substratum. Some six miles from the river lay one of the central main mountain ranges, the intervening space being occupied by small mountain streams, numerous rolling wooded hills and flats.

At night the air was pure and delightfully cool. Great reluctance was felt at having to leave such a district, where the scenery is of a very fine description. There is apparently a large population here, but the people would no doubt be friendly. When descending the river the steam launch Ruby collided with a treacherously concealed snag and foundered. This unfortunate accident compelled the party to travel down an open, unprotected coast in the whale and river boats. The Kumusi natives were unusually interesting. They are from a light to a dark bronze color, not remarkably powerful people, but of fair Papuan physique. Their foreheads are square and rather high, with hazel eyes of fair size, large mouth, small chin and flat cheeks and chests. The nose resembles that of Port Moresby, only slightly shorter, and the nostrils rather coarser. Both sexes wear cloth of mulberry bark. They use stone clubs, the disk and the pineapple pattern, the palmwood spear with square-shaped sharp end and barbs on one side only, and small Gothic shields, with a few examples of the great shield of Orangerie Bay. The stone clubs and adzes are made of basalt. They have no tobacco growing in their gardens, and were ignorant of its use. Their canoes are similar to those on the Ikore and Mambare Rivers. It was found that a river of considerable size enters the sea at Cape Sudest, but unluckily a bar closes its entrance to navigation. The natives call it Tambokoro.

The position of Cape Sudest was determined astronomically, and found to be in lat. 8° 44' S. and long. 148° 25' 30" E. In Dyke Acland Bay three streams were discovered—Kevoto and Umundi Creeks and the Musa River. The mouth of the first of these lies in lat. 9° 4' 55" S. and long. 148° 33' 20" E. Both creeks are of little importance. The lower part of the Musa River traverses low, swampy country, covered by water when the river is flooded. When ascending this stream the Administrator passed within a few miles of the western peaks of Mount Victory. "It has three principal summits, the western one of which is at present quiescent." Ashy-looking deposits were observed among the rocks on the others, and several large fumaroles out of which little spiral clouds of smoke were issuing. The highest point reached on the river was about thirty-five miles from the sea in lat. 9° 19' 10" S. and long. 148° 53' 43" E. Here the stream was about 100 yards broad, three fathoms deep and the current two to three knots per hour. This place was evidently on the margin of a settled country. The banks of the river were beginning to rise, and the capacity of the channel was about sufficient to carry the water. The forest trees were very large. What the upper portion of the Musa basin may be is at present unknown, but

the lower part appeared to be of little value. Several villages occupy the flooded country on the banks of the river; the houses are built on stilts a few feet above the water.

The natives were friendly, but naturally shy and suspicious. They excel in making native cloth, many specimens of which were obtained. Their dead are interred in the villages, the graves being covered with a neatly thatched cage. They use palmwood spears, stone clubs and adzes of jade. Both sexes wear a native cloth. The men wear the hair long, hanging down the back. They cook their food in clay pots and eat lime and betel nut. The men were fairly strong and of good physique, but many were suffering from ringworm and hydrocele. They were anxious to trade, and offered adzes, clay pots and sago for plane irons. Some very remarkable pottery was obtained on the northeast coast. The examples are bowl-shaped with outside raised designs, not previously seen in any other part of British New Guinea. Besides these explorations, the discovery of Pennegwa Harbor, in the extreme northeast of Rossell Island, and a safe anchorage at Mabudaun, which very greatly increases the value of the western portion of the Papuan territory, were described.

Mr. Thomson, by means of a map, indicated the territory dealt with in his paper, and at its conclusion a few pictures appropriate to the occasion were thrown on to the screen by Dr. Thomson.

In the course of some remarks, Sir William McGregor suggested that Mr. Thomson might follow up his paper with another. The one he had just read did not embrace all the latest work that had been done. His (Sir William's) dispatches had not all been printed; in fact, he questioned whether some of them had yet reached his excellency the governor. There was a great deal of information which might be included in such a paper. Mr. De Vis had been examining a number of new and interesting native birds; Baron Von Muller had got a lot of new plants; but perhaps the most interesting, because the most practical, was the work being done by Mr. Jack and Mr. Rands. The geological specimens he had brought from the Purari River indicated a very large district in which there were very rich coal formations. The fossils that were under examination would show very clearly, he thought, the age of the deposit.

[FOR THE SCIENTIFIC AMERICAN.]

THE HORSE AS A HIGH SPEED ENGINE.

By R. H. THURSTON.

A STUDY of the records of fast horses during the last half century throws some light on the rate of development of the animal as a high speed engine and, incidentally, at least, gives some facts that may prove useful in the investigation of the principles of operation of the vital machine and methods of increasing its efficiency. The records here produced cover the period from 1850, and are classed in such manner as to bring out the effects of improvement of horse and of vehicle. The record to-day stands as follows :*

ONE MILE RECORDS, 1850-1894.

Pet, ro. g., pedigree unknown, East New York, N. Y., September 9, 1852 (Horace Jones)	2.19½
East New York, September 9, 1852	2.18½
Pocahontas, ch. m. (8), by Iron's Cadmus, dam Dine Mare, by Probasco's Shakespeare, East New York, N. Y., June 21, 1855 (J. D. McMann)	2.17½
Jim Brown, ch. g., pedigree unknown, San Francisco, Cal., October 13, 1873 (O. A. Hickok)	2.17⅛
Sweetser, gr. g. (9) by Gosnell's Tom Crowder, dam Lady Farlow, by Gray's Tom Hal, Cleveland, Ohio, October 3, 1877 (A. M. Wilson)	2.16
Sleepy George, b. g., by Belmont Bill, dam unknown, Rochester, N. Y., August 7, 1878 (W. H. Crawford)	2.15
†Sweetser, San Francisco, Cal., December 25, 1878 (John Splan)	2.15
Sleepy Tom, ch. g. (11), by Tom Robbe, dam Dingler Mare, by Sam Hazzard, Columbus, Ohio, July 16, 1879 (Joseph Udell)	2.14½
Chicago, Ill., July 25, 1879 (Joseph Udell)	2.12¼
Little Brown Jug, br. g. (6) by Gibson's Tom Hal, Jr., dam Lizzie, by John Netherland, Hartford, Conn., August 24, 1881 (W. H. McCarthy)	2.11¾
†Johnston, b. g. (6) by Joe Bassett, dam Carey Mare, by Sweeting's Ned Forrest, Chicago, Ill., July 16, 1883 (P. V. Johnston)	2.11¾
†Chicago, Ill., October 9, 1883 (P. V. Johnston)	2.10
†Chicago, Ill., October 3, 1884 (John Splan)	2.06¼
†Directum, blk. s. (6) by Director, 2.17, dam Echora 2.23½, by Echo, Independence, Iowa, September 4, 1891 (George Starr)	2.06
Mascot, b. g. (7), by Deceive, dam Miss Delmore, by Austin's Messenger, Terre Haute, Ind., September 29, 1892 (W. J. Andrews)	2.04
†Flying Jib, b. g. (8), by Algona, dam Middletown Mare, by Middletown, Chicago, Ill., September 15, 1893 (John Kelly)	2.04
†Robert J., b. g. (6), by Hartford, 2.22¼, dam Geraldine, by Jay Gould, 2.21½, Fort Wayne, Ind., August 31, 1894 (E. T. Geers)	2.03¾
Indianapolis, Ind., September 6, 1894 (E. T. Geers)	2.02½
†Terre Haute, Ind., September 14, 1894 (E. T. Geers)	2.01½

The era of fast horses may be said to have commenced about 1860. Flora Temple trotted a mile in 2.19¾ in 1859. The progress made to date may be gauged by the fact that in 1892-3 there were about 7,500 records of 2.30 and under by different trotting horses and 1,500 by pacers, and there are certainly not less than 10,000 horses on the lists, up to date, that equal that performance.‡

Running horses have nearly attained the speed of about a mile in 1.30, or forty miles an hour, thus :

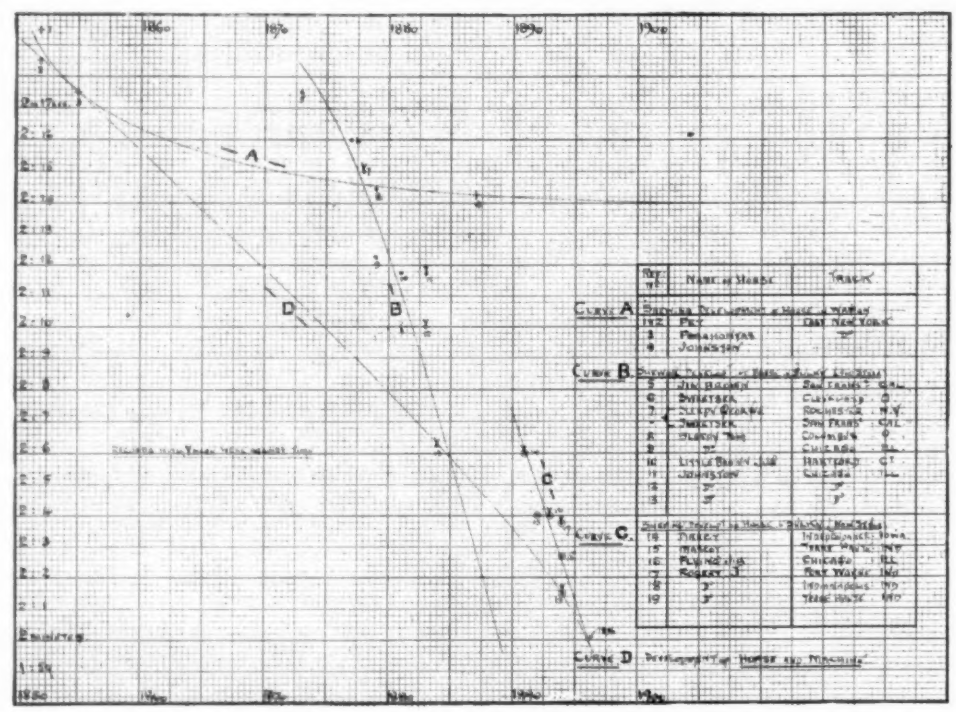
1865—Legal Tender	1.44
1887—Ten Broeck	1.39¾
1890—Salvator	1.35½

The time for four miles runs thus :

1855—Lexington	7.19¾
1874—Fellowcraft	7.19½
1876—Ten Broeck	7.15¾

The pacing horse has a higher speed than the trotter, and the lowest records are held by pacers. Jay-Eye-See illustrates this point : trotting her mile, and making her best record as a trotter, in 2.10, and as a pacer, later, in 2.06¼.

The official record is, in a sense, incomplete. It shows the successive figures as record after record was "broken" by a new "champion ;" but it gives no idea of the rate at which the race of high speed horses is increasing. During the half century the figure for one mile heats has been lowered from about 2.30 nearly to 2.00, and the "two minute horse" is likely to appear at any moment. But, while the speed has been continually increased, the number of fast horses approximating the maximum speed of the time has also continually increased, and there are a number of horses to-day of whom much is expected and who are known to be able to closely compete with those standing in the van. It is further interesting to note that the pacing gait is evidently a faster gait than the trotting, the principal records for fastest time having been usually held by pacers. The number of fast horses has now so greatly increased that the average "champion" at the county fairs about the country trots or paces in about 2.30, and horses making the mile in 2.25 are also numerous, and those taking the record 2.20 not infrequent. This increase in the proportional number of fast horses makes the improvement of the record, and the consequent improvement also of the stock of the country, more certain and steady than ever before. The approximation to a two minute gait is now



close, indeed may be completed before the close of the next season. It will be interesting to learn what have been the promises in this direction, as interpreted from the record to date under various usual conditions of trial.

The plate exhibits the records of the table and the curves illustrate more clearly than could any tabulation the rate of progress to date, and the outlook for the immediate future. The data naturally group themselves into three sets and the curves are obtained from each of these sets and an envelope curve is added. Curve A is that for three early and one late record for the old fashioned wagon; B is the record for the old form of sulky, and C is that for the recent improved sulky with pneumatic tires, while D is the envelope curve. The first exhibits the progress of the animal with the wagon; the second is that of the horse to sulky; the third shows the improvement of the animal illustrated by performance with the latest sulky, and the fourth exhibits the gain due to improvement both of animal and of wagon. The best figure with the old wagon is 2.14; the best with the old sulky is 2.06¼, and the best with pneumatic tire is, to date, 2.01½.* The change from wagon to sulky gave a gain of eight seconds; that from old to new sulky about five seconds.

Studying these diagrams, it is seen that the weight of the load and its resistance count for a great deal, and, as would have been predicted, the higher the speed, the greater this effect. If the horse can exert, for the time of one "heat," a total work power at the rate of 2,000,000 foot pounds per hour (1,980,000 foot pounds per hour measures James Watt's conventional horse power), a resistance of 200 pounds will permit a speed of but 10,000 feet, two miles, nearly, per hour. Reducing the resistance to 20 pounds, the same expenditure of vital and physical energy would give a speed of about twenty miles an hour—a mile in three minutes. Could the animal develop the same external energy at equal advantage at the higher speed, the reduction of the resistance to ten pounds would give a speed of forty miles an hour for one mile, and a record of 1.30. But the effect of load is more serious than the above would indicate. The internal work of the machine is a sensible quantity and increases with speed, and possibly at a high rate. If it consists, as seems certain, of work of friction of circulation of fluids, friction in such case varying as the square of the velocity of flow, the power thus consumed will vary as the cube of the rate of pulsation of the heart, and the resistance to display of energy externally is thus enhanced, and the external energy developed by the machine as a prime motor is to this extent reduced. The larger the external resistance, the more is the internal expenditure of energy increased, and possibly in higher proportion than the external.

The form and location of Curve A seem to indicate that the old-fashioned wagon had thus seriously limited the possibilities in the high speed development of the horse, and that not much better than a mile in 2.14 could have been expected. No such limit is indicated on the other curves; but the best work in the old sulky was 2.06¼, and progress had apparently ceased. The new sulky rapidly drops the record, and it seems very possible that the present season, or the next at latest, may see the figure still further and considerably improved by the introduction of the aluminum sulky, reducing the weight from about 30 to 20 pounds, and by all the methods which are above indicated.

Noting the trend of the curve for the present conditions, we see that it points toward the date 1896, on the two minute line, and the group 15, 16, 17 shows that it is not unreasonable to expect a possible variation in the date of two or three seasons from the line of the curve. We may reach two minutes next season, if Gentry or Robert J. or other promising young horses come forward, as hoped and expected by their trainers, or it may be a year or two later; but it is evident that we may reasonably expect it, and soon. Were the latest curve to be continued to 1900, we should pass the two minute line in 1896, and at the end of the century attain a speed of a mile in one minute and fifty-five or six seconds, above thirty miles an hour for the single mile. This rate has already been approximated for a half mile and bettered on the quarter. The running horse has come down to a much lower figure already, making his mile at the rate of above forty miles an hour.

Comparing the four curves, it is seen that the improvement of the animal has been more effective, on the whole, and more steady and persistent than improvement in the apparatus to which he is attached. Gain must probably be slow in both directions, and the limit of reduction of resistance of vehicle and that of resistance to internal work are probably alike close at hand. The gain by breeding and change of form of the high speed horse takes effect by improving the relation of weight of muscles, and of form of body and limb, to the new conditions of vigor and power, and of speed of the animal, by giving the creature more of the deer shape and proportion of limb, and increased power in the development and the application of energy in this specific direction.

The wonderful power and speed of the contemporary "fast horse," studied from the point of view of the engineer and of the man of science, has peculiar interest as illustrating the highest result in the development of the vital machine which corresponds to the development, in the case of the steam engine, of the high speed engine; the expenditure of energy of a limited amount at maximum velocity of mechanism.

But little has been accomplished in the direction of investigation of the methods of energy transformation in the machine; but the measure of the power latent in the food supply and of the work performed in various ways is coming to be determinable. The quantity of "energy" supplied is known for the average case; the amount of internal work performed, as measured by the quantity of heat into which it is transformed finally, and thus rejected from the system, is approximately ascertained; and the external useful work is in some cases determinable. There is a remanent quantity of work still to be traced out and measured, including that of the work performed incidentally to the ordinary vital operations of life and movement, but not included in the "useful work" called the day's work. Possibly some mental and nerve

* New York Tribune, Sept. 23, 1894.

† Against time.

‡ See Johnson's Cyclopedia; Art., Horses.

* It is said that 1:57½ was actually made in the season of 1894, but not in such manner as to establish the record.

ower may be also thus classed; but it seems more probable that all that kind of work is to be classed as internal, and ultimately measurable as heat. Progress in the high speed animal, or vital engine, is made in part by reduction of external work performed, as by reduction of the friction and road resistance; in part, and in large part, by the development of the power of storing and developing rapidly large quantities of energy concentrated in available form for this special purpose. At lowest speeds, as those of the cart horse, power is limited by the strength of muscles applied to slowly raising or pulling maximum loads; at high speeds, as in fast running, trotting or pacing, the limit is found in the power of the muscles to rapidly overcome small resistances externally, and to perform mainly the internal accession of work of respiration, circulation and simple motion of limbs. The draught horse devotes his powers largely to external, the fast horse largely to internal work. It is by comparison of these works and the energy supply stored in the food, with the balance measured as heat, that a clew is likely to be obtained to the methods of energy transformation of the vital machine.

This vital engine derives its powers from the stored energy of the chemical compounds, all of them combustible, which are included in its "food" and which correspond to the fuel of the heat engines. The average ration contains from 1,500 to 2,000 calories of heat, 6,000 to 8,000 B. T. U., nearly, per pound, as supplied, accordingly as the grain—for it is, in the case considered, always grain—is weighed in its ordinary condition or with all moisture expelled by kiln drying. Of this potential energy the animal receives each day about 30,000 calories; total supply, 120,000 B. T. U., nearly, or about 90,000,000 foot pounds, in available form, and from 20,000,000 upward is wasted by incomplete digestion and nutrition in the average case, although the waste in the most favorable cases may be taken as more nearly fifteen per cent. of the total supplied.

The energy supplied in available form may be taken as distributed approximately as follows, a favorable case being taken:

BEST EFFICIENCY OF THE VITAL PRIME MOTOR.

Total Energy Supplied Measured in Foot Pounds Per Day.	Energy Expended Measured in Foot Pounds Per Day.
90,000,000 foot pounds.	External work... 20,000,000 Internal work... 70,000,000 90,000,000 Efficiency 22 per cent.

The external work is partly the useful, paying work of the day's labor, in part that of incidental operations, as the going to and from the work, the various motions and movements of the creature, with or without intention, which every animal, from various motives, exhibits at all times. The paying work may, in a representative case corresponding to the above, be taken as about 1,500,000 foot pounds per working hour, or 12,000,000 per day. Commercially reckoned, therefore, the efficiency is to be measured by this output, and becomes on this basis about 13 per cent. The first of these figures is almost precisely that attained by the very best existing steam engine; the latter corresponds to the efficiency of what would be rated as a good average marine or stationary engine of the best modern type.

The internal work consists in the production of respiration, the circulation of the blood, the operations of digestion and assimilation and that of the brain and nervous system. Rubner has shown that the total heat discharged from the body is that which the food is capable of producing by its oxidation, and this indicates that all internal work finds its final transformation into heat, and that the food supplied in excess of this amount furnishes the balance, if any, of heat required to maintain the temperature of the system at its normal and working point. As the internal work is mainly that of friction of fluids in the veins, arteries and capillaries, this final transformation is precisely what might have been predicted—which was predicted by the writer—before the fact was known by experiment.

Hirn also, many years ago, proved that the vital machine at work discharged less heat per unit supplied and oxidized than when at rest, and thus showed what also might have been predicted, that the transformation of energy into external work reduced by a corresponding amount the quantity transformed finally into heat.

Chauveau has recently concluded, from extended research, that all work performed by the vital machine is done at the expense of its stored potential energy, consuming the degenerating tissues of its own mass, and the fats stored away in their midst; which conclusion is confirmed by the fact, that even without food, work may be performed, and all the functions of the machine sustained effectively, for days together. Messrs. Joule and Scoresby, nearly a half century ago, showed that the animal machine, performing work at the rate, in the case of the horse, of 24,000,000 foot pounds per day, developed 143 foot pounds per grain of supply, and in place of its theoretical value, 557, giving an efficiency of 26 per cent., which is, as they state, two and a half times as much as the best Cornish pumping engine of their time could attain, but only about one-half that of the Daniell battery, burning zinc. All later investigations have confirmed, in a general way, their conclusions. It is certain that the vital machine is not a heat engine, and its efficiency is superior to that of any known thermodynamic machine. As Sir Wm. Thomson, Lord Kelvin, has suggested, it is probably an electro-magnetic engine, or in some way closely related to that form of motor.

The "fast horse" has peculiar interest to the scientific man and especially to the engineer, as illustrating the case of the maximum efficiency of the mechanism, apart from the energy transforming system. Taking the resistance of the best sulky on the track as ten pounds, at speed, and that of the wind as $0{\cdot}002v^2$ and the "head resistance" on that basis, as a total, at $2 \times 6 \times 30^2 \times 0{\cdot}002 = 21{\cdot}6$ pounds, the "record breaker," at thirty miles an hour, meets an aggregate resistance, for two minutes, of about 31·6 pounds and develops about 25 horse power for that brief period. The average day's work of a horse of similar weight cannot be assumed at more than 25,000 foot pounds per minute for eight hours a day, and the conclusion is that, by skillful breeding and training, the mechanism of the vital machine has been brought to such perfection that it can develop over thirty times as much energy as the energy transforming system can render available for prolonged external work, concentrating into two minutes the normal work of an hour. The aim and real purpose, scientifically stated, of the breeder is to secure this power of concentration and application of stored energy. That of the breeder of the heavy classes of horse employed by the engineer for transportation of his material is to secure power of extensive development of storage of energy with steady transformation in maximum degree for a full working day. We have no data for the study of results such as are presented herewith in the case of the first problem; but the rate of improvement is probably slower and steadier, and the outcome of the work no less gratifying, even if not far more important.

These matters are interesting and important to the engineer and the man of science; but they have another a more remote, but probably vastly more important, bearing upon his future work. The study of the vital machine reveals the fact of the existence of energies and methods of transformation for useful application which are still mysteries; but they may—the indications are that they will—ultimately give us the clew to enormous economies in our economical employment of the great forces of nature stored away, in past ages, for the use of mankind.

One of the ablest of contemporary philosophic writers, criticising alike Spencer and the sociologists, Darwin and the man of science, and Kidd among the critics of both classes, says:*

"One has only to read the average book of science in almost any department, to wonder at the wealth of knowledge, the brilliancy of observation, and the barrenness of idea. On the other hand, though scientific experts will not think themselves, there is a multitude to do it for them. Among these what strikes one is the ignorance of fact and the audacity of the idea."

This is, in the sense in which the statement is intended, correct, but it is the main business of the man of science to ascertain fact, and then to trace the law, finally employing a scientific imagination in the development of, not their own ideas, but the idea which is expressed in the fact and the law. In this, science is not remiss, and the world is the wiser and the better for that caution in formulating opinions without basis of exact knowledge. Opinion can never be substituted for fact, in science. In many fields science has not yet developed the foundation of either fact or law to a sufficient extent to construct the idea, and this is peculiarly true in some departments of most exalted importance, as, in the present case, in relation to the phenomena of physical life. But the brightest minds of the scientific world are now, in continually larger numbers, turning toward the problems of vital mechanism and energy transformation; and physicist, chemist, and biologist, hand in hand with the engineer, are gradually developing the facts and laws and the fundamental idea of this still mysterious vital engine.

THE DADDY LONGLEGS.

By E. A. BUTLER, B A., B.Sc.

THE advancing autumn has brought with it the usual visitation of swarms of "daddy longlegs," and it will no doubt be acceptable to the readers of Knowledge if we take the opportunity, while the discomforts of the visitation are still fresh in the mind, of setting before them an account of these fragile but none the less troublesome insects. The chief cause of the inconvenience to which they subject us in their adult state is the awkward way in which they tumble about, blundering up against us with the tickling sensation of buzzing wings and straggling legs, or immolating themselves in the gas or lamp flame, and startlingly dropping their singed and mutilated bodies on to the page which we may happen to be reading or writing, but, as we have had occasion to remark before, it often happens that the most harmful period of an insect's life is not that which is most prominently before human eyes; the greatest damage wrought by an insect pest is often done in secret, when the real cause of injuries is generally unsuspected. Such is the case with the insect now before us, for the inconvenience caused during its period of publicity is as nothing compared with the havoc wrought by it during its earlier life of seclusion, when its aspect is so different from that of the well known "daddy" that none who were not in the secret would suspect the identity of the two insects.

The "daddy longlegs" with which we are most familiar is but one species of a large group, the family Tipulidæ, and of one very extensive genus in that family, the typical genus Tipula. Thus the name "daddy longlegs" is, strictly speaking, not a specific designation, but a general term, and there are large numbers of insects to which it may be and is equally appropriately applied. Still, it is no doubt a single species which is usually understood by the term—a grayish-brown fly, with semi-transparent wings, the brown nervures of which stand out distinctly on the lighter background. The thorax is hoary beneath, and the six long legs are brown at the base and blackish toward the tip. To this species the name Tipula oleracea has been given. The great length and slenderness of legs in these creatures has recalled the corresponding feature in wading birds, and has led to their getting the name of "crane flies." In France they are known as "tailors" and "seamstresses." The great length of legs is not altogether disproportionate; it finds correlated characters in the other parts of the body, and is no doubt of some assistance to the insects in walking in the grassy places that form their principal habitat.

We may now endeavor to get such an exact notion of the form and structure of our crane fly as will be obtained by a close examination, assisted by the use of a hand lens of low power. The single pair of wings marks it out as a dipterous insect, and we may at once notice that the wings are usually carried, when at rest, not folded together over the body, as would be the case with most flies, but widely open and slightly elevated on each side, as though to be ready for use at a moment's notice. Their extreme narrowness at the base, as well as for some distance along their length, is indicative of that feebleness of flight for which the insects are noted—a feebleness which is, however, perfectly compatible with a rapid and rattling vibration of the wings.

If this wing be compared with that of a strong flier, such as a bluebottle, a striking difference is seen. The bluebottle's wing is furnished with a sort of extra flap of membrane at its base, which, when the wing is extended, fills up the space between its broader part and the body; while in the crane fly this space is quite open and unoccupied with membrane. This appendage to the true wing is called the "alula," or winglet. Projecting from the hinder part of the thorax into this open space is, on each side, a delicate little organ, the so-called "balancer," a sort of clubbed stalk, whose intimate structure is well worth careful study. Now it is a curious fact that in the two flies we have mentioned, these two parts, the winglets and balancers, appear in inverse ratio of size. The strong and vigorous bluebottle, which has a very large winglet of most exquisite structure, has a completely insignificant balancer, which requires close search to discover it at all; whereas the weakling crane fly has no trace of a winglet, but has proportionately the largest balancer that is to be found among British Diptera. And this is only one illustration of the law of correlation of structures, of which many others may be observed in the same two insects. Consider, for example, the following details of symmetry and contrast: in the vigorous and active bluebottle we find a stout heavy body, short legs, short, strong wings with large alulæ, a short, compact head, insignificant balancers, and a body beset with stout bristles. In the fragile and weakly crane fly all these points are reversed, and we find a long, slender, light body, very long legs, long, narrow wings without alulæ, a long and tapering head, large and conspicuous balancers, and a smooth and bristleless body.

The shape of the thorax, strongly convex and humpbacked above, is worthy of notice, as representing in an almost exaggerated degree the general plan of dipterous structure in that part of the body. Remembering that each of the three pairs of legs represents a separate division or segment of the thorax, it will be comparatively easy to trace the limits of these regions, by following the junctions upward from the points of attachment of the legs. It will thus be seen that the prothorax, or first region, is reduced to very small dimensions, forming no more than a sort of collar, just behind the head. The metathorax, or third division, a much larger mass, will be found behind; but when we have marked off these two parts, there still remains the greater portion of the thoracic mass, which is thus proved to belong to the second segment, or mesothorax. If we bear in mind that this is the division which, in insects generally, carries the fore wings, and that in flies the fore wings are the only pair developed, the reason for the great development of this part will be at once evident, for within its cavity are stored the muscles that are instrumental in working the wings. There is one feature of the mesothorax that is specially characteristic of the family we are now considering, a trivial feature no doubt, but one which is helpful in distinguishing Tipulidæ from other groups. Across the middle of the upper surface runs a V-shaped furrow, which is not to be found in other groups of flies, for the rest of the order either have a smooth surface here, or if a transverse impression is present, it is incomplete, not V-shaped. At each side of the thorax will be seen two narrow slits, one just above and behind the insertion of the first pair of legs, and the other at the base of the balancers. These are two of the spiracles, or entrances to the breathing tubes, which, as with insects generally, traverse all parts of the body and convey air to the system at large.

The head (Fig. 1) is most peculiar in shape, being

FIG. 1.—Head of Daddy-longlegs.

prolonged into a sort of beak. The basal part is almost globular, and the compound eyes occupy a large part of the surface here. In life they are of a bright green color, a very pleasing relief to the somber tints of the rest of the body; unfortunately, however, the color is fleeting, and passes away after death. At the end of the beak are two jointed organs, which, when not in use, are carried bent back underneath the head; these are the maxillary palpi. The upper part of the head carries the antennæ, a pair of long, jointed tapering organs, with circles of delicate bristles at the junctions of the joints. The form of the antennæ decides at once to which of the two great divisions of flies the crane fly belongs, viz., the Nemocera, or "thread horns." This, again, is another respect in which it differs markedly from the bluebottle and other flies of that robust type which have short and most oddly shaped antennæ. It is hardly necessary to say that no biting jaws exist in the perfect insect. No power of biting or piercing is possessed by it, and hence its harmlessness in this stage, whether to man, beast or plant.

The legs, as already mentioned, are exceedingly long and slender, each of the divisions being elongated to a considerable extent; the tarsi, or feet, which are five jointed, with the joints diminishing in length as they recede from the body, are even longer than the tibiæ. They are not only long and slender, but also very fragile and easily broken off, an accident to which the

* The Ascent of Man; Drummond.

insects are extremely liable, but at the same time one which cannot be regarded as of a serious character, for the loss of even half the number of its legs does not prevent the insect from going about its business as though nothing had happened. Such losses can hardly be attended with much pain, and their chief influence would no doubt be felt in the difficulties in steering during flight, which would follow. Unlike crabs and lobsters, the daddy longlegs does not possess the power of reproducing a lost limb, nor indeed would the power be of any avail if it existed, since the insect's adult life is too short to allow time for any such restored limb to grow.

The hinder part of the body differs markedly in the two sexes. In the male it is blunt and swollen, the enlarged part containing a complex reproductive apparatus; but in the female it tapers regularly to a hard and sharp point. This acute tip (Fig. 2) is the

FIG. 2.—Ovipositor of Daddy longlegs.

hardest part of the body, and necessarily so, as it has to do the hardest work, and indeed the only serious work that devolves upon the fully matured insect. It constitutes an egg-laying instrument of superior quality, and is composed of four pieces disposed in pairs. On the upper side are two long and pointed pieces which form the sharp tip, and are used as borers, and underneath these is the other pair, considerably shorter, broader and blunter, their function being to guide the eggs in their passage into the hole prepared for them by the pair of borers. The whole apparatus, therefore, is something like a combination of an auger and a spoon.

The eggs are small, shining black, and slightly curved. When they are about to be laid the mother insect behaves in a most remarkable manner—in a manner, indeed, that might have been thought impossible had it not been actually witnessed. It will be remembered that in those animals in which a distinct longitudinal axis of the body can be traced—such, for example, as vertebrates and arthropods—the almost universal position of that axis is horizontal, the chief exceptions being man and birds, whose use of only one pair of limbs in walking throws their axis into an erect or sloping position. So in insects and other arthropods, as the bipedal arrangement does not exist, one naturally expects to find the axis of the body placed horizontally when the animal is walking over a level surface, and in fact it is a most exceptional circumstance that any other disposition should occur. When, therefore, it turns out that the female daddy longlegs, on its egg-laying expedition, actually struts about on its hind legs with its body placed in a perfectly erect position (Fig. 3), it will be admitted that we are justified in considering this most extraordinary behavior.

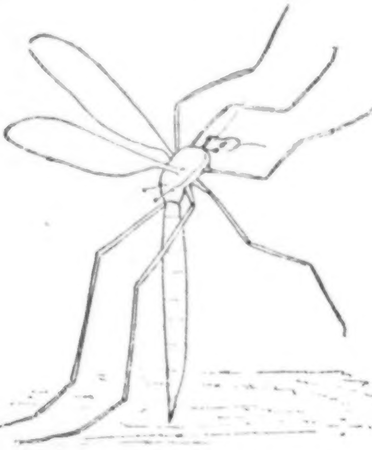


FIG. 3.—Attitude of Female Daddy longlegs, when on an egg-laying expedition.

Considering the structure of the legs, however, it is evident that the proper balancing of the creature, if it had to depend on its hind legs only, would be a somewhat nice operation, and hence the pointed abdomen is requisitioned as an auxiliary, and is used as a third prop. Most ludicrous is the sight as the insect, rearing itself perfectly erect, and flourishing its four front legs in the air, goes hobbling along on its tripod, prodding its pointed body into the ground at every step, while the legs bend like springs as it does so. Such a sight may often be seen in the proper season on damp grassy spots where the insects are plentiful, and they may be watched with ease, for there is no fear of their shyly retiring from observation, since they are far too intent on their work to notice the presence of an intruder.

When a suitable spot has been found, the ovipositor is plunged into the ground and kept there while several eggs are passed down into the hole. Sometimes, however, they are laid among the grass or leafage close to the surface of the ground, instead of being buried. As many as three hundred eggs may be produced altogether by a single female, but they are not all laid in the same spot, and it is difficult to say what determines the number to be included in a single set, unless it be the proportionate abundance of food. The different groups, however, are often laid tolerably close together, and in bad visitations this is necessarily the case. Kirby and Spence record an instance in which the immense number of two hundred and ten grubs were found in a square foot of turf during a terrible plague of them in Holderness in the year 1813.

From the black eggs are hatched thick, grayish, footless grubs, with an extremely tough skin. They are generally known to gardeners as "leather jackets," or simply as "the grub." They are soft and flexible, but so tough that it is difficult to damage them by any means short of absolutely cutting the body in two or tearing it to pieces. This feature they possess in common with another subterranean grub, which the reader will be careful not to confound with the "leather jacket," viz., the celebrated wireworm, or grub of skipjack beetles; this creature differs in being thin, hard, inflexible and of a yellow color. Though the "leather jacket's" head is large, it is not generally seen, as it is almost entirely embedded in the following segment. It is furnished with powerful jaws which are forked at the tip. The entrances to the breathing tubes are reduced to two openings placed at the tail end of the body; here are also some pointed hooks, which, like the head, are usually withdrawn within the adjoining segment when not in use. They are of assistance when the grub works its way through the soil.

This wretched grub is subterranean in habits, and if it does chance to come to the surface, it is only in the night time, or under the shelter of some friendly stone or pile of dead leaves. Its business underground is to devour the roots of plants, and this business it discharges most effectually. It possibly does damage also by loosening the soil round the roots as it works its way about. Its diet certainly seems to suit it well, for it is usually found in a very fat and flourishing condition. Its principal food appears to be the roots of grasses, but it is by no means confined to these. I have found it very destructive to certain garden plants, especially to blue lobelias used as an edging. Shortly after the young seedlings have been bedded out, they begin to look unhealthy and droop and wither.

Frequently also the previously erect stems fall into a sloping position and wither away. On removing the soil from the base of the plant to investigate the cause of its drooping condition, a fat "leather jacket" is found in the center, just where the rootlets ought to be; the tendere. portions of these have all disappeared and only the tougher and older parts are left, while many of the stems are seen to be gnawed round or cut completely through at the base, thus explaining their prostrate position and withered appearance. In such cases, unfortunately, one does not discover the enemy till the mischief has been done, and it is too late to save the plant. Of course, such damage is the more likely to occur where the bed is bordered by a grass plot.

This destructive work is carried on by the grubs more or less continuously during the summer months, from May to July, and sometimes they may be found at work even as early as February. During this time, far more than what is actually devoured is caused to perish through the removal of the roots. But it is only fair to remark that some slight plea of defense may be advanced, which will perhaps serve to take the edge off the charge of wholesale destructiveness which must otherwise be made. In eating the roots, the grubs inevitably swallow a good deal of earth, and, in fact, to such an extent is this the case, that so careful an observer as Reaumur thought they lived upon this rather than upon roots; hence they may perform to some slight extent a service similar to that carried out by worms, in the passing of earth through their bodies.

Toward the end of summer the grub becomes a chrysalis while still buried in the soil. It now appears as a long, brown, narrow object, which shows indications of the parts of the future fly. The legs are present, but bent up at what will ultimately be their joints, in three parts, which lie parallel to one another on the under side of the head and thorax. The thigh points toward the tail, then the shank is bent back upon this, and finally the tarsus or foot points again in the direction of the tail. By this arrangement all the tarsi are made to lie on the outer side and to terminate at about the same level. Of course, these legs, being inclosed within the membranous skin of the pupa, are quite useless for purposes of locomotion.

When the fly is fully formed and ready to make its appearance in the air, the chrysalis works itself up through the soil to the surface by means of certain spines on the abdomen, which point outward and slightly backward. Using these somewhat as climbing irons and props, it works its way upward, step by step, until all the fore part of the body is above ground. Its legs are now free from the soil, and when drawn out of their sheath, after the splitting of the skin, can be used to assist in extricating the body. But in order to give purchase to the struggling insect in its endeavors to get free from its case, the lower part of the chrysalis remains embedded in the ground, and the body is withdrawn from the shell, which is left projecting half way out of the soil (Fig. 4). These empty

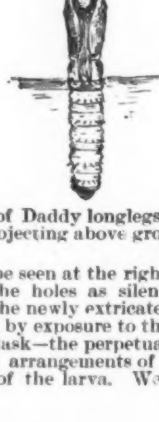


FIG. 4.—Pupa of Daddy longlegs, with upper part projecting above ground.

cases may often be seen at the right season still standing upright in the holes as silent witnesses to past resurrections. The newly extricated fly is at first soft, but soon hardens by exposure to the air, and proceeds to its appointed task—the perpetuation of its kind.

The breathing arrangements of the pupa are as peculiar as those of the larva. We have already mentioned that the spiracles of the larva are reduced to a single pair, which are to be found on the last segment of the body. Similarly, the pupa has but two, but these are at the opposite extremity—a very desirable arrangement, as this is the part that is uppermost, and therefore nearest the air, when the insect works its way to the surface. They form two horn-like prominences, which project considerably from the head. Thus, in the daddy longlegs, the same restriction and reversal of respiratory structure takes place as in the aquatic larva and pupa of the common gnat.

As these insects are so destructive, an important question arises as to the best means of reducing their numbers and checking their ravages. As damp soils, with plenty of loose, straggling vegetation, especially grasses, are particularly favorable to their multiplication, it is evident that drainage and the clearance of weeds are two of the most important means of prevention. Untidy, shady corners often harbor scores of specimens, while on open, cleared spaces in the immediate vicinity they may be sought for in vain. The larger insectivorous birds are certainly of great service in clearing the soil of the "grub;" indeed, according to the belief of Mr. Verrall, the English dipterologist, rooks are by far the best remedy. But perhaps we cannot do better than refer those who are practically interested in the matter to Miss E. A. Ormerod's "Manual of Injurious Insects," where they will find variety enough to make a choice rather embarrassing, since most of the remedies suggested have been found useful on occasion.

But we must caution our readers against putting too much faith in specific remedies, or expecting too much of them, since it is extremely difficult, if not impossible, to obtain an "infallible cure" for insect depredations of any kind. The circumstances of each different visitation, even of the same insect, often vary considerably, and what would be efficacious in one instance might altogether fail in another. Again, just as the satisfactory working of a small model of machinery is by no means always a guarantee that the same thing would work well on a larger scale, so insecticides that may be perfectly efficacious and very rapid in action when administered direct in the laboratory to an individual specimen may fail altogether when the attempt is made to apply them promiscuously, and on such a scale as would be necessary in a large field, to say nothing of the great expense often involved in attacking such large areas. Of this principle, indeed, Miss Ormerod gives some remarkable illustrations in the book above referred to, appending to them the following pertinent remarks: "The above experiments are of much value by showing how little these remedies can be depended on, some of which have often been tried, and time, valuable for checking the attack at the beginning, thereby lost. It will be observed that the application that caused the most rapid destruction of life experimentally failed to have any decided effect on the grubs in the ground, even when applied at a strength which, without the greatest care in using, would be destructive to the crop."

Probably natural agencies are, after all, the best to depend upon; but even in this category there are several that might have been thought available, but yet fail through the hardiness of the grub. For example, frost, which kills many insects, has little effect upon the hardy "leather jacket." They may be frozen hard and stiff, and yet recover on being thawed, and proceed about their business as usual. In some experiments carried out for Miss Ormerod, at Kew, specimens were exposed to an artificial cold of $-10°$ F., or 42 degrees below freezing point, and some were found to resist even this extremely low temperature, though most of them died. Therefore, evidently the frost of an ordinary winter cannot be expected to make much difference to their numbers. Again, it was found that grubs which had remained immersed in water for fifty-eight hours, and looked quite lifeless, recovered on being restored to the air, though an immersion twice as long proved fatal. Hence floods, to be effectual in killing the grubs, must be of long continuance, and there must be no means of escape to drier quarters. Drought appears, however, to be much more reliable as a destroying agency.—Knowledge.

SOCIAL INSECTS AND EVOLUTION.*

By Professor C. V. RILEY.

EXPERIMENT and discussion on the question as to whether acquired characters are transmitted or not through heredity have of late been largely based upon the economies of insects, and especially of the social species. The author gives a summary of what is known of the habits and economies of bees, wasps, ants and termites, especially as to the development of the young. He points out that the origin of neuters, with their diversified forms, in these social insects, has been considered one of the greatest difficulties which the theory of natural selection has had to contend with. Weismann, in urging his own particular theories to account for the variations which organisms have undergone, insists, and has, within the last year, in his controversy with Herbert Spencer, emphasized his belief that these neuter insects absolutely preclude the idea of the transmission of acquired characters. The author believes, on the contrary, and endeavors to show, that while these neuters among social insects, with their varied structures and habits, do, indeed, offer serious obstacles to the theory of natural selection as an all-sufficient theory to explain the phenomena, these are nevertheless perfectly explicable upon the general principles that have governed the modification of organisms, among which natural selection plays an important but limited part.

Among the social Hymenoptera, where, as in the bees and wasps, the larva is nursed and brought up in a definite cell or cradle, the three castes of male (or drone), fertile female (or queen) and neuter (or worker) are quite definitely fixed and separated. The differences between the worker and the queen are, however, solely due to the treatment of the larvæ, and are consequently under control of the colony. The same larva, according to treatment and nurture, may produce either a perfect queen or a worker, between which the differences as to size, structure, external and internal organization and length of life are very great.

* Abstract of a paper read before the British Association for the Advancement of Science, Oxford, August 13, 1894.

This is absolutely and definitely proved for the bees, and is doubtless equally true, though with less absolute proof, of the wasps, in which the same three casts of male, female and neuter obtain in some species, while in others the neuters are replaced by parthenogenetic or unimpregnated females, normally capable of reproducing.

In the ants, where the larva is not confined to a definite cradle, and where there are, in the more typical species, two casts of neuters, viz., soldiers and workers, the variation between the different casts is greater, and there is also more variation in the individuals composing the different casts; but the evidence all points to the fact that these different individuals are also the result of food and nurture, very much as with the bees and wasps.

In the three families of social Hymenoptera above mentioned, the young are maggot-like and absolutely helpless and dependent on the nurses. In the termites, which belong to a different order (Platyptera), much older in time, according to the paleontological record—an order in which the young are born in the image of the parent, and are more or less independent from birth—one would expect to find larval nurture and environment less potent in influencing ultimate structure. Yet all the facts known, and particularly the late most painstaking observations and experiments of Grassi, prove conclusively that here, also, the young are dependent upon the nurses, and, more remarkable still, may be diverted, according to the food and treatment given, to any of the four casts which characterize the typical termite colony, there being, in addition to the male and female, two kinds of neuters, viz., soldiers and workers, as in the true ants. In the first larval stage, or when first hatched, the individuals are, to all appearances, absolutely alike, and each possesses the potentiality of becoming either a worker, or a soldier, or a perfect sexed individual. Nay, further, the pupæ, or nymphs, may be diverted into reproductive forms which never acquire wings, and which are called supplementary queens and kings; and even larvæ may be so diverted into reproductive forms with no further external structural development, when they become complementary or neotinic kings and queens.

The steps in the development from the simpler to the more special structures and attributes belonging to the species with the most perfect social organization may be traced in the different species and genera of their respective families in all social insects of the present day. The amount of variation is often great in the ants and termites, where the environment is less fixed than in the bees and wasps, and this variation, among termites, is particularly manifest in the economy of the same species as exemplified in Eutermes, which the author has studied in the West Indies and in which the number of queens varies from one to nine or more. It is not generally known, but it is a fact, that existing termites (using the term in the broader sense, so as to include several genera) exemplify all the steps in development from species which are active in broad daylight (the neuters having faceted eyes and dark integument and, so far as is known, no definite nest or termitary) to the more specialized species in which the economy and division of labor are most perfect, and in which the neuters and soldiers are blind and always work in the dark and build elaborate structures. Further, the neuters in termites are truly without sex or are modified individuals which might have produced either sex, while in the Hymenoptera they are invariably modified females.

In so far as these different forms of neuter insects depend for their development on the food and treatment given by the nurses, they are outside the domain of natural selection. The author believes, however, that there is a potential inherited tendency in the young larva to develop in the various directions that have been fixed for each species in its past development, as he cannot believe, e. g., that young larvæ taken from one species of termites, and brought up under the care of the nurses of any other species, can be diverted to the forms peculiar to this last. There is a possibility, since the food of these young in the social insects consists largely of secretions from the nurses, that these secretions may so influence the changes as to confine them to the specific forms of its own species, regardless of the parentage of the young. That there can be any such powerful influence of nurture that would neutralize and overcome the inherited tendencies of species is, however, extremely improbable; its bare possibility opens up a most interesting field for experiment, which is easily made and doubtless soon will be made.

The author believes, with Darwin, that the variations in social insects have been guided by natural selection among colonies, but that there has also been what he calls social selection among individuals. Competition has been between colonies rather than individuals, and those colonies which have acquired, through heredity, the habit of producing, from one or more fertile females, the different casts characteristic of the species, have, in course of time, survived. He believes, however, that this colony selection, as well as the social selection among individuals, has been not only along lines that were and are useful to the species, but along lines of secondary utility, and even along lines which are purely fortuitous and still most variable and unfixed.

Finally, as between Weismann's views and those held by Darwin himself, the author feels that the facts furnished by the social insects strongly favor the transmission, through heredity, of acquired characters, both psychic and structural, but that they also require other factors besides that of natural selection to explain them.

The trouble with all theories of reproduction and heredity based solely on embryologic and microscopic methods is, that the essence, the life principle, the potential factors, must always escape such methods. Any theory that will hold must cover the psychical as well as the physical facts—the total of well established experience; and this truth was recognized by Darwin in framing his tentative theory of pangenesis. We are all in these matters simply discussing processes, and the author believes that too much has been made of the cell theory, the cell being but the medium through which assimilation, growth, organization, regeneration, and reproduction are effected by the ultimate elements and the inherited potential forces, call them what we may. The idea that the individual during its lifetime develops all that is potential in the germ seems to him more philosophic than the idea that the germ originates, at a specific moment of time, the tendency to all that develops in the individual. It may be a perfectly correct conception, to use Weismann's language, that the primary constituents for the characters of the different forms of social insects are included in the egg and that a particular form of stimulus decides as to which group shall undergo development; but it is difficult to believe, in the light of the facts concerning social insects, that the different kinds of ids and determinants which are thus conceived to characterize the germ have not been impressed upon it as a consequence of the characters, both acquired and congenital, of the parents.

The paper finally calls attention to the significant fact that, just as in man, among mammalia, the higher intellectual development and social organization are found correlated with the longest period of dependent infancy. That this helpless infancy has been, in fact, a prime influence in the development, through family, clan, tribe, and state, of our highest organization and civilization; so in the insect world we find the same correlation between the highest intelligence and dependent infancy, and are justified in concluding that the latter is, in the social insects as in man, in the same way a prime cause of the high organization and division of labor so characteristic of them.

[FROM THE NINETEENTH CENTURY.]

FRUIT RANCHING IN SOUTHERN CALIFORNIA.

By AN ENGLISHMAN.

THINKING there may be many other young men situated as I was a year and a half ago, I venture to give my experience, in the hope that it may be of some little use.

Two years ago last spring I was brewer in a London brewery, and while there was taken ill with a bad attack of pleurisy and pneumonia, and on my recovery, the doctors strongly advising against my remaining in town, found myself with nothing to do. After spending some months at home, trying to get another berth, I noticed a letter in t e Field from a farmer in Canada, which first turned my thoughts to emigration; my father, knowing a gentleman who had nephews somewhere in America, made inquiries of him, and found that they were doing very well fruit farming in California, also that an Englishman owning a large fruit ranch about ten miles from this place was then in London.

Hearing this, I went up and saw Mr. H——, the abovementioned gentleman, who gave such a glowing account of colonial life that I settled to go out and prospect; so, as he was returning shortly, we made arrangements to travel together.

We left England in February, 1893, and came straight through to his ranch at El Toro. I was much struck by the various changes of climate we passed through on the journey.

When we left Chicago there was a severe snow storm raging, and we could hardly keep warm enough, but after a day or two's run it was just the reverse, and we spent a good deal of time on the platform at the end of the car. They are very free and easy out here, and don't mind what you do on the train as regards riding on the platforms and getting on and off while in motion, very different from the order of things in England.

I expect nearly every one knows that all trains out here are vestibuled, and one can walk from one end to the other.

The cost of the journey from England to Los Angeles or San Diego, for first-class accommodation the whole way, including food, sleeping berth on the train, cab fares, tips, etc., amounts to about £45.

A through ticket from New York on can be got at Cook's, London, but they don't book sleeping berths; however, if required, their agents meet you on the boat at the wharf at New York, also at Chicago, and get you your berth and see to checking your luggage through; there is no bother about looking after your things, as they are checked through to their destination. One hundred and fifty pounds weight is the limit on the cars, and overweight is charged at high rates. It is a good thing to have as little as possible to carry with you, as there is not much accommodation in the Pullmans for packages. Mr. H—— and I had eleven between us, and lots of bother they caused, till we tipped the porter to stow them away in his private cupboards.

We came by the Pennsylvania Railroad from New York to Chicago, and thence by the Sante Fe route, the most direct, and which runs a daily through train from Chicago to San Diego, California. It is a twenty-six hours' trip from New York to Chicago, and four nights and three and a half days from there to San Diego. Part of the way they run dining cars, and after that have stops at suitable times for meals. It is advisable, though, to have some light provisions with you, as occasionally they are delayed for a few hours between stations by breakdowns or washouts. That happened to us. A freight train ran off the track ahead of us, delaying us five hours; fortunately we had some food, and joining with another party in the car had quite a jolly picnic.

It is well, if one gets out to stroll about at any stopping place, to keep a close watch on the train, as there is no guard to come round shutting doors, etc.; the conductors just call out, "All aboard!" and off they go. The journey, on the whole, is uninteresting, mostly through deserts, though there are some interesting features, Indian villages, crossing the Rockies and the Canon Diablo, a gulch about three hundred feet deep, a quarter of a mile wide, extending nearly eighty miles.

I had asked Mr. H—— what would be my best plan on arrival, and he most kindly offered me work at regular wages while I was looking about, which offer I gladly accepted.

Just at first I found the hours from sun-up to sundown rather long and trying, especially as we were "baching," viz., doing all our own cooking and housework, quite a new experience to me, and rather interesting, though I soon got tired of it; but they told me to go easy at first, and after a few days the time seemed to fly.

Work on a fruit farm is a very varied and a great part of it done with horses. The usual hours when working by the month are from sun-up to sundown—that is, you are supposed to get your breakfast and have your team ready to start work as soon as it is light enough during the winter, and finish up, having all chores done (feeding horses, cleaning stables, tc.) by 6 o'clock P.M. In summer you start about 6:30; when working by the day you start at 7 A. M., and quit at 6 P. M.; wages by the day are 6s., and by the month about £8. Of course, when you are working on your own ranch you please yourself about the hours. I usually get up at 7 o'clock and breakfast at 8, unless plowing or doing anything particular.

After working on Mr. H——'s ranch a few months and having looked around the neighboring country well, I came to the conclusion that I liked El Toro better than any other place having the same advantages, so I bought twenty acres of land and started fruit farming.

I got my house and barn built by contract. We are very well situated here in that way, as an English resident in this valley has built several of the largest houses by contract and has given entire satisfaction.

El Toro is very prettily situated, surrounded on three sides by hills on the main line of the Sante Fe route, about half way between Los Angeles and San Diego, two and a half hours by rail from either, and about half an hour from Santa Ana, a very rising little town.

There are one freight and two passenger trains each way daily; so access to the neighboring towns is easy. There is a daily mail here, but we have to fetch our own letters, as there is no delivery.

The valley lies pretty high, and on a clear winter's day a big range of mountains about 150 miles away can be seen. It is very pleasant, and at first seemed very strange to me, to sit out of doors in the sun during the winter, and see the hills around covered with snow.

We are about six miles from the Pacific, where there is quite a little village, cottages owned by people of the neighboring towns; and during the season Lajuna is quite gay; parties often go down there from here for bathing. There is a daily stage service between El Toro and the beach, and usually one can hire a furnished cottage there for £2 a month. When I first arrived here there was one hotel, a grocery store, the houses owned by Englishmen, and a few small fruit ranches; since then there have been built three more houses for English families, and several smaller ones for American ranchers; a butcher's, a barber's, another general grocery store, a blacksmith's shop, a large warehouse, and a lumber yard have also been established.

There is a nice little English church, and we have service every Sunday evening. At present Captain H——, one of our English residents, acts as lay reader, but we hope soon to have a clergyman; there is rather a difficulty in arranging it, as this place is not large enough to wholly support one, and the other English churches in the neighborhood are rather far away, Tustin, the nearest, being twelve miles.

There is also a very decent middle class free school, with an average attendance of thirty.

At present there are six English families resident here, and several bachelors. We have a good lawn tennis club, and have started cricket. We can just muster an eleven, so with the shooting (there are plenty of quail and rabbits up in the hills and several places for duck quite near) there is always something going on.

The climate here is lovely: no rain during the latter part of spring and the whole summer; beautifully mild winters, though this year we have had it colder than any of the old Californians can remember: several times the thermometer has reached freezing point, which is most unusual. Generally during the day while the sun is up it is warm enough to sit out of doors, but gets quite chilly toward evening. The summers are moderately hot, but then again the nights are cool, and it is very seldom one cannot sleep under blankets.

Most days there is a gentle breeze blowing between 10 o'clock A. M. and 4:30 P. M. We get lots of mists during the night time, but they disappear as soon as the sun gets up.

I worked out of doors all last summer and never found it unpleasantly hot, except through the hot winds from the desert, which are horrible while they last, generally three days; we only had one bad and two slight ones last year. Down here they go by the name of the Santa Ana winds, but in Santa Ana they pass the compliment on to the next town, and call them Riverside winds.

Houses are not very expensive to build; a good house of two bed rooms, dressing room, bath room, and screened in scullery, dining room and servants' bed room, 10 foot veranda on three sides, hot and cold water laid on, finished in best style, plastered and painted throughout, costs about £400. Bachelors as a rule build a two-roomed house finished inside with ceiling, costing £40 to £50. Nearly all the country houses in this locality are built entirely of wood, one story high and raised a little off the ground. Then there is a tank house—the tank is nearly always outside—which costs [about £40, that is for one finished up with two small rooms one above the other. An open one costs very much less. The barn, stables, carriage house, and saddle room are as a rule all under one roof. A barn 20 × 30, main floor, five stables, 5 × 14, harness room, 5 × 14, a buggy shed, 14 × 30, costs £80.

Many people have their barns open at the ends, but it pays to have a good tight one on account of the mists.

Water in this country is struck at from 16 to 20 feet; in my own case we reached water at 17 feet and went down 7 feet further, and now I cannot pump the well (4 feet square) dry, running the pump with a gasoline engine and throwing a one-inch stream.

The majority of ranchers use a windmill to drive the pump, but with an engine one is sure of the house supply, and if you have a good well you can do a lot of irrigating for vegetables, etc. The engines are exceedingly easy to run, and very economical, costing about 1s. 3d. per day of ten hours, and after starting them up you can leave them entirely for two or three hours at a time. A three horse power costs £60. I have one, and also a barley crusher, which is a very

good investment, as the nearest mill is at Santa Ana, fifteen miles away, and I get a lot of crushing to do for my neighbors.

A 1,200 gallon wooden water tank costs £5, iron ones are a little dearer. Well digging can as a rule be contracted for at 4s. a foot, four feet square, till water is struck, and then by the day, the man down the well getting 10s. per day and the others ordinary wages.

Fencing is very cheap; I had 760 yards of fencing done, two wires, posts thirty feet apart, and it cost altogether £7.

A good working or driving team of two horses can be had for fifty or sixty pounds. They always measure horses by weight in California, hands are unknown; saddle ponies cost about £10 apiece; a good fresh milch cow fetches £10, hens 24s. per dozen, and young pigs 10s. to £1 each.

There is no good government land about here now, and land suitable for fruit growing costs £20 per acre in El Toro, that is about the usual price for fruit land except near towns, or where it is under an irrigating ditch, where it ranges from £20 to £40.

The land in our valley is especially adapted to fruit growing, as it lies so level that the rain does not run off at all, and owing to the loamy quality of the soil readily sinks in; for the same reason it is easily kept well cultivated, so as to get the full benefit of all the moisture.

Most of the wells here show a depth of sixteen feet of rich loamy soil, and the buyers last season all remarked on the fine quality and size of the fruit grown here.

The best-sized ranch for one man is between twenty and thirty acres. That gives one plenty to do without having to slave. It is advisable when choosing your land to try to get a little rise to build on, and so get the benefit of all the breezes. I was very lucky in that respect; the hill rises gradually from the road about 250 yards away, and then drops suddenly; so I built the house on the top, and had the barn down behind, quite out of the way, and we look clear over it from the house. Land for grain can be rented for a quarter or a fifth of the crop, or 4s. to 8s. per acre, depending on the quality; this year there will be about 7,000 acres in grain around here.

The usual feed for horses is barley, hay and rolled barley; the hay is allowed to head out about three-quarters, and is then cut, left on the ground two or three days, then bunched with a rake, and is ready for use. The price of good baled hay this year is 35s. per ton, about a fair average.

There is a very good market for ordinary farm produce, such as eggs, butter, etc., though just at present prices are very low; eggs 5d. per dozen, and butter 8d. per lb.; young chickens are worth about 1s. each, and hogs 2½d. per lb. live weight.

I should think the best plan for any one meditating settling in California would be to get into correspondence with some one out here before leaving England, then on arriving he would have somewhere to go to find out the best means of getting about and seeing the country before purchasing. It is best to go either as a pupil (premiums need not be paid, as many ranchers are very glad to take a pupil and board him and teach him all they can in return for his work, though if you do pay a small premium you don't have to rough it so much nor work so hard), or else to stay on a ranch, where you can get a good insight into the work and general management before starting ranching.

At present in El Toro there are about 300 acres set out in fruit, about half planted this year. Mr. D—— W—— set out 100 acres in orchard five years ago this spring in this valley, proving by the manner in which the trees have grown that they would thrive and yield fruit without irrigation.

The general method of cultivation is to plow deep and get the ground thoroughly broken up and fine to a depth of three or four inches before setting out any trees, then as soon as the orchard is planted to cultivate and harrow sufficiently to keep weeds down and the surface loose and fine, which prevents evaporation.

There are a great many cultivators and harrows especially designed for orchard work, most of them riding tools, and drawn by two horses. The majority of fruit growers plow their orchards at least once a year, though I know an orchard which has done well and has not been plowed for two years. Where fruit will grow without irrigation there is a great saving of labor, as every time you use water you must cultivate the land before it gets dried out and baked by the sun.

The greater parts of the orchards here are set to prunes and apricots; both bear a fair crop at four and a half years, apricots rather the larger of the two. Both fruits are dried, so can be held if prices are low. Up to the present there has been no difficulty in getting help locally to handle the crops, and as more trees come into bearing we shall always be able to get help from the neighboring towns to help us out. Before the crops are picked, buyers and commission agents come round, but of course with dried fruits there is no particular hurry. The drying is very interesting work; apricots are cut in half and pitted, then spread on trays, put in the sulphur house for a few hours to bleach, and after that left in the sun till sufficiently dry. Well canned fruit is almost transparent.

Prunes are dipped into boiling water and lie for a minute or two to crack the skin aad allow the inside of the fruit to dry, and are then spread in the sun in the same way as the apricots are.

On four and a half acres of 4½-year-old apricots (seventy to the acre) in El Toro last year the owner got nearly twenty-four tons of ripe fruit, which dried out to about four tons. When trees are older the shrinkage is less, as the first year the fruit is borne on the old wood and does not get enough sun to give the best results.

They were harvested last July and beginning of August, and in October dried apricots were selling free on board the cars at shipping point for 5¼d. per pound, cash business. In December and now these same are worth 5½d. to 6¼d. per pound, according to quality, and may possibly advance another ½d. before the new crop comes in.

The cost of handling crop, viz., picking, pitting, sulphuring, sorting and drying, is 1d. to 1¼d. per pound on the dried weight, depending upon how regularly the fruit ripens. Sacks to hold a hundred pounds cost 3d. each. Prunes don't bear quite as heavily in proportion the first year. They got last season about eighty tons of fruit off ninety acres, a hundred trees to the acre, which dried out to about twenty-six tons. This crop from the trees into sacks costs about ½d. per pound to handle, and on a large scale can be contracted for at a slightly lower rate. Prunes now are 2d. per pound, that is the small size, eighty or ninety to the pound; fifty to sixty to the pound are worth in Chicago 3½d. to 3¾d., and larger ones, forty to fifty to the pound, 4d. to 4¼d.

All these quotations of prices are taken from the most conservative paper on the coast, the Californian Fruit Trade Review for February 17, 1894, and the present year is acknowledged by all to be one of frightful depression. In the same number of the Review an instance is cited of a Mr. B—— having got fifty-five tons of apricots and forty-seven tons of prunes, each off five acres, the trees grown and in full bearing. The other instance I can vouch for, as they came under my personal experience. Details of other fruit crops I cannot give, as there are no other sorts of trees bearing here, except home orchards.

The cost of the different trees varies considerably from year to year, but there is a downward tendency. This year oranges and lemons four to five feet high, strong well-grown trees, were 15l. per 100. Apples, pears, peaches, nectarines, almonds, figs, etc., 2l. Apricots, 2l. 10s., and prunes 1l. 15s. per 100. Grapes grow very well and bear largely here out of doors. Semi-tropical fruit and ornamental trees also thrive; there are a few instances close here in which dates and bananas have ripened their crops.

The necessary tools for a fruit ranch do not amount to a great cost. One needs a 12-inch plow, 2l. 8s.; an 8-inch one for getting near the trees with one horse, 1l. 12s.; a cultivator, about 11l.; a harrow (the Acme harrow is the best, as it crushes up all clods), 7l., or a drag harrow, 4l.; wagon, 20l.; and shovels, picks, hoes, etc. If you plant corn between the trees, you need a small cultivator, 2l.

Carriages are very cheap; you can get a very nice buggy for 30l., and a cart, a little two-wheeled affair, useful for breaking horses in, for 4l. Harness is also cheap; good buggy harness for a single horse, 6l. to 8l., work harness, 8l. per double set.

English saddles are very difficult to get hold of, and the Mexican saddles are uncomfortable for any one used to the English ones; it is all balance riding, the stirrups are straight below you, so have to be long with the leg straight; they are very heavy, weighing about forty pounds, with a high peak in front and behind.

Poison is quite an item at starting, as the country is overrun with ground squirrels, which are death on corn, trees, etc., but after you once get them killed off, they are very little trouble to keep down. There are occasionally rattlesnakes met with, and lots of tarantulas, large poisonous spiders; they claim that the latter will come at you, and can jump a foot or two, but all I have seen I have tested with a stick, and have never come across a jumper; the bite is supposed to be as poisonous as a rattlesnake's, but I have never heard of any one round here being bitten, and there are a good many about, so perhaps they are not as bad as painted.

No particular outfit is necessary for this part of California. English summer underclothes are quite enough for winter, and some flannel shirts for working in. The usual working costume is flannel or calico shirt, blue jean trousers, "copper riveted spring bottom pants," 5s. a pair. Boots are cheap, but cloth clothes are very dear, and are subject to a high duty. A friend of mine had two suits sent out a few months ago, and had to pay 3l. duty on them, so it is as well to bring a good stock.

The roads, except the county ones, are decidedly bad; they are simply earth, so after the rain, cut out very much. The main roads are kept in a little better order, but none of them are anything to brag about. Still, the buggies are very easy riding, and one soon gets used to the bumps, though at first I often used to think of our smooth English highways. One advantage of these roads is that they are never rendered almost impassable through mending.

The cost of living in the country out here is considerably less than in England, especially leaving out the question of servants, or help, as it is called here.

While we were baching when I first came out, our bills used to come to about 30s. a month apiece; then we had butter, milk and eggs free. Working on a ranch and paying for your board, the usual charge is 1l. 15s. per month. At most of the country hotels you can get a room and good board for 1l. a week. Since I started housekeeping, four adults in family, I find our meat bill has averaged 2l. per month (beef is from 5d. to 7d., and mutton 4d. to 6d. per lb.), and groceries about 6l. per month; eggs, butter and milk off the ranch. We bake our own bread, as is the custom, so the baker's bill is included in groceries. A Chinaman comes round twice a week with vegetables, which are very cheap, and occasionally we get fresh fish brought up from the beach.

It pays to wash all clothes but house linen at home, as the prices charged are pretty stiff, but house linen is cheap.

Cotton goods are about the same price to buy as in England. Woolen goods are dearer and not so good. Furniture is cheap; most of it is lighter in style than the English, and usually made of light oak; a solid good bedroom suite, of double bed, washstand and dressing table, costs from 7l. to 10l., light oak well made and finished; the washstands and dressing tables are fitted with drawers and cupboards.

Wages for domestic help are cruel. A general servant gets about 4l. a month, and a cook 6l.; they are all very hard workers, and out here hardly any one has more than one, but the English find them more familiar than they have been used to. Some of them expect to take meals with the family and have the use of the sitting room and occasional use of the horse, so you want to be a bit careful when engaging one; they leave when they choose without notice, and written characters are unknown.

My wife finds the best and cheapest way of managing, as every one here helps in their own homes, is to have a girl about fifteen years old at 8s. a week, who does all the rougher work in washing, cleaning, etc.

I will just say in conclusion that I thoroughly enjoy this life, and have never been in better health and spirits than during the last year.

To sum up, I bought 20 acres of land for 400l. twelve months ago, and have spent in all so far between 1,500l. and 1,600l., having the whole 20 acres set out in orchard. I have also rented 40 acres; half I have in barley and wheat, and the rest ready for corn.

In four and a half years from the beginning of this year (by which time I shall be 26 years old) my returns from the orchard will commence, and my outgoings, about 200l. a year, ought to cease, by which time I calculate I shall have spent in all about 2,500l., and in a year or two more, as the trees come into full bearing, I should be living comfortably on my ranch, besides saving at least 5 per cent. on capital invested.

As examples of an ordinary day's work I take two days.

January 8.—Got up at 6:30, fed horses, cleaned stables, milked. Breakfast at 8, after which, took team and wagon up to town, and hauled home lumber and corn. Dinner at 12:15. After dinner fixed corral for pigs, then ground some corn, attended stables, cow, etc. Supper at 6, bed at 8:30.

February 27.—After breakfast watered ornamental trees round house, and caught vermin; after dinner rode down to see the barley crop and corn land.

I see that a big cut rate war has just started between Santa Fe and Southern Pacific Railways, and they say rates will be extremely low shortly, a good opportunity for any one wishing to see this country.

A. C. TWIST.

El Toro, California, February, 1894.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
361 Broadway, New York, N. Y.

TABLE OF CONTENTS.

PAGE

I. AGRICULTURE.—Fruit Ranching in Southern California.—An interesting and attractive description of farming in California from an English standpoint, by a participant in the life described...... 15781

II. ANIMAL ECONOMY.—The Horse as a High Speed Engine.—By R. H. THURSTON.—An examination of the mechanics of animal progress and the possibilities for the future.—1 illustration........ 15778

III. ARCHITECTURE.—The Reliance Building, Chicago.—A Chicago building enlarged from 5 to 14 stories height.—Specifications for the work, with plans and elevation.—2 illustrations................ 15775

IV. BIOGRAPHY.—James Anthony Froude.—Life of the English historian and controversialist.—With portrait.—1 illustration 15768

V. DOMESTIC ECONOMY.—The People's Kitchen in Vienna.—By EDITH SELLERS.—Elaborate account of this institution, of its staff and methods and review of the field it fills.................... 15768

VI. ELECTRICITY.—On Some Magnetic Characteristics of Iridium.—By S. H. BRACKETT.—An interesting investigation involving the production of a diamagnetic needle......................... 15776

"The Electric Lady."—A description of the methods used in this museum entertainment.............................. 15776

VII. ENTOMOLOGY.—Social Insects and Evolution.—By Prof. C. V. RILEY.—An abstract from a recent British Association paper by the late United States Entomologist.............................. 15780

The Daddy Longlegs.—By E. A. BUTLER.—The English daddy longlegs or crane fly.—Its habits and life.—4 illustrations.......... 15779

VIII. MEDICINE AND HYGIENE.—Modern Developments of Harvey's Work.—By Dr. T. LAUDER BRUNTON.—Second installment of this valuable paper, giving notes of the life of the great anatomist and the results in modern times of his labor.................. 15772

Removal of Large Numbers of Nails, etc., from the Stomach by Gastrotomy—Recovery.—By A. W. MAYO ROBSON.—A very curious instance of curing a child who had swallowed nails.—Persistence of the habit.. 15773

Prolonging Life.—An interesting and practical paper on longevity.. 1577?

IX. NATURAL SCIENCES.—Meeting of the National Academy of Sciences at New Haven.—Notes of the personnel of this meeting and of the papers read and work done.......................... 1576?

X. NAVAL ENGINEERING.—The Compactum Evaporator and Distiller.—A compact distilling apparatus for use on ships for producing fresh water.—1 illustration.............................. 1577?

XI. ORDNANCE.—Penetration of Modern Rifles.—A very valuable and timely paper on modern ammunition and small arms.......... 15771

XII. PHOTOGRAPHY.—The Dusting process.—By H. H. BUCKWALTER.—A curious system of photography involving a reproduction of the image by a beating of dust.......................... 1577?

XIII. PHYSICS.—Calorimeter for Testing Coal.—How the value of coal for heating purposes is determined, with full description of the apparatus.—3 illustrations.................................. 1577?

The Koniscope.—By Dr. J. G. MCPHERSON.—A very curious investigation of the color phenomena of steam in dusty air and its application to determining dust particles quantitatively........... 15776

XIV. RAILROAD ENGINEERING.—Locomotive Injectors.—By GEORGE H. BAKER.—Notes on an elaborate committee report on this subject, with tables of results.............................. 15770

XV. TRAVEL AND EXPLORATION.—Recent Exploration in British New Guinea.—A paper read before the Queensland Royal Geographical Society by its president, Mr. J. P. THOMPSON, on recent work in the exploration of this little known country....... 15777